es
2

MARYLAND & RARE BOOK ROOM
UNIVERSITY OF MARYLAND LIBRARY
COLLEGE PARK, MD.

Digitized by the Internet Archive
in 2015

https://archive.org/details/annualreportofma25mary

THE TWENTY-FIFTH

ANNUAL REPORT

OF THE

MARYLAND AGRICULTURAL
EXPERIMENT STATION

COLLEGE PARK,

PRINCE GEORGE COUNTY, MARYLAND

1911–1912

Archives
UFLIB
A33.04

PUBLISHED BY THE STATION

2320

The Maryland Agricultural Experiment Station.

CORPORATION.

The Board of Trustees of the Maryland Agricultural College.

Agricultural (Station) Committee of the Board of Trustees.

Governor P. L. Goldsborough, (Ex-Officio)	Annapolis.
Chas. A. Councilman, (Chairman)	Glyndon.
F. Carroll Goldsborough	Easton.
Robert Crain	Baltimore.
J. Harold Walsh	Upper Falls.
E. Gittings Merryman	Cockeysville.

STATION OFFICERS AND STAFF.

Harry J. Patterson	*Director and Chemistry.*
Samuel S. Buckley	*Animal Pathology.*
J. B. S. Norton	*Botany and Plant Pathology.*
*Thos. B. Symons	*Horticultural Demonstrator.*
N. Schmitz	*Agronomy.*
E. H. Brinkley	*Farm Superintendent.*
Thos. H. White	*Vegetable and Floriculture.*
Chas. O. Appleman	*Plant Physiology.*
B. M. Bolton	*Biology.*
A. B. Gahan	*Entomology.*
Roy H. Waite	*Poultry.*
W. R. Ballard	*Pomology and Small Fruits.*
W. E. Hanger	*Assistant Agronomist.*
L. B. Broughton	*Assistant Chemist.*
H. J. White	*Assistant Chemist.*
Roy C. Towles	*Clerk.*
C. C. Longnecker	*Stenographer.*
H. Ford	*Treasurer.*

---

*On State Horticultural Department Work.

The Station is located on the B. & O. R. R. and City and Suburban Electric Car Line, eight miles north of Washington, D. C.

Bell Telephone—Hyattsville Exchange.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION,
College Park, Md.

LETTER OF TRANSMITTAL.

To His Excellency, P. L. Goldsborough,

Governor, and President of the Board of Trustees,

Annapolis, Maryland.

SIR:—In accordance with the provisions of Section No. 3 of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the honor to transmit the Twenty-fifth Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1912.

Very respectfully yours,

H. J. PATTERSON,

July, 1912.

Director of the Experiment Station

CONTENTS.

Page.
Letter of Transmittal.................................. iii
Report of Director.................................. v
Administration and Divisions of Work...................... v
Investigations vi
Demonstrations vii
Financial Condition and Appropriations.................... vii
Publications xii
Investigations in Progress................................ xii
Soil and Fertility Investigations.......................... xiii
Grain and Forage Crop Investigations...................... xiii
Horticultural Investigations xiii
Botanical and Pathological Investigations.................. xiv
Plant Physiological Investigations........................ xiv
Entomological Investigations xiv
Poultry Investigations xv
Dairy Investigations xv
Dairy Demonstrations and Extensions...................... xv
Demonstration Work xvi
Needs of the Station..................................... xvi
Recommendations for Consideration of the State Board........ xvii
Seed Inspection xvii
State Biological Laboratory.............................. xvii
Bulletin No. 155: "Maryland Weeds and Other Harmful Plants" 1
Bulletin No. 156: "Rose Mildew 73
Bulletin No. 157: "Some Experiments with Poultry"........... 81
Bulletin No. 158: "Miscellaneous Greenhouse Experiments"..... 97
Bulletin No. 159: "Peach Culture" 111
Bulletin No. 160: "Strawberries" 193
Bulletin No. 161: "Treatment for the San Jose Scale and Terrapin Scale Insects" 221
Bulletin No. 162: "The Quality of Seed"..................... 235
Bulletin No. 163: "Increasing the Durability of Fence Posts"... 243
Bulletin No. 164: "Lime-Sulfur as a Summer Spray"........... 263
Bulletin No. 165: "Boys' Corn-Growing Contest in 1911"...... 273
Bulletin No. 166: "How Is Lime Distributed Through and Lost From the Soil"......................... 285
Bulletin No. 167: "Changes in Irish Potatoes During Storage".. 327

THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

Vol. 25 1911-1912.

TWENTY-FIFTH ANNUAL REPORT OF THE MARYALND ARGRICULTURAL EXPERIMENT STATION.

For the Year Ending June 30, 1912.

By H. J. PATTERSON, Director.

To the Board of Trustees of the

Maryland Agricultural Experiment Station.

Gentlemen:—I have the honor to submit herewith a report of the work of this Institution for the past fiscal year, together with recommendations for the work and expenditures for the next year. A few suggestions are offered for your consideration with reference to the needs of this Institution for its future development.

Administration and Divisions of Work.

The following outlines will give a general idea of the scope of the work which is being pursued and the parts which are allotted to the different members of the staff.

INVESTIGATIONS.

Soils	Fertility studies with Lime, Fertilizer and Manure.		H. J. Patterson. L. B. Broughton. E. H. Brinkley.
Crops	Grains, Hay, Forage and Green Manure crops. Breeding, Culture, Varieties, etc.		N. Schmitz. W. E. Hanger
	Horticultural Crops. Breeding, Fertilization, Culture, Irrigation, Varieties, ets.	Stone Fruits and Nuts.	
		Vegetable and Floriculture. Under glass and out-doors.	T. H. White.
		Pome, Bush and Vine Fruits.	W. R. Ballard.
	Botany and Plant Pathology.		J. B. S. Norton.
	Plant Physiology and Chemistry.		C. O. Appleman.
	Tobacco—Breeding, Culture, Varieties and Fertilizers. In cooperation with the U. S. Department of Agriculture.		W. W. Garner. D. E. Brown.
	Entomology—Life History, Spraying.		T. B. Symons. A. B. Gahan. E. N. Cory.
Animals	Poultry.	Diseases—B. M. Bolton. Commercial Problems—R. H. Waite.	
	Milk Studies—S S. Buckley.		
	Feeding Experiments.		H. J. Patterson. H. J. White. R. S. Allen.

Demonstrations.

Conducted in Co-operation with Agricultural High Schools, Granges and Farmers' Clubs.

Soils.	Fertilizer and Lime.		H. J. Patterson. W. E. Hanger.
Crops.	Horticultural.		T. B. Symons. W. R. Ballard. E. N. Cory.
	Corn Contests—Alfalfa.		N. Schmitz. W. E. Hanger.
Animals.	Dairy	Cow-testing Association. Cow-breeding Association. In cooperation with U. S. Department of Agriculture.	G. H. Hibberd. F. J. Maxwell. W. T. Woodruff. J. W. Kinghorne. J. L. Taylor. W. MacMonnies. F. B. Hardin.

Financial Condition and Appropriations.

The Station is in its usual satisfactory financial condition. All work has been conducted within the Station's income. All bills have been paid at the end of each month and oftener when discounts are allowed for cash. Owing to the failure to promptly fill the vacancy caused by the resignation of Dr. Gage not so much has been needed for salaries under the Adams Fund and more has been available and spent for equipment.

The last Legislature appropriated $3,000 for each of the next two years for demonstration work. This amount is not sufficient to establish a separate department for this class of work. As the Experiment

Station could probably handle this small amount to better advantage than any other division now in existence, I would recommend that this fund be expended under the direction of the Experiment Station and that it be used to supplement the demonstration work now in progress.

The details as to the past year's expenditures are as follows:

	HATCH FUND.	ADAMS FUND.
Receipts from Treasurer of the United States, as per appropriations for fiscal year ending June 30, 1912, under acts of Congress ap- March 16, 1906 (Adams Fund)	$15,000.00	$15,000.00
CR.		
By Salaries	$10,680.95	$10,415.69
By Labor	2,872.19	264.75
By Publications	192.13	....
By Postage and Stationery	6.75	20.25
By Heat, Light and Water	....	525.69
By Chemicals and Laboratory Supplies	....	386.88
By Plants and Sundry Supplies	14.75	220.39
By Fertilizers	208.23	....
By Feeding Stuff	295.96	1,118.60
By Library	276.04	408.51
By Tools, Machinery and Appliances	....	294.95
By Furniture	48.00	106.25
By Scientific Apparatus and Specimens	....	217.97
By Live Stock	380.00	300.00
By Traveling Expenses	....	18.85
By Contingent Expenses	25.00	....
By Building and Land	....	701.22
Total	$15,000.00	$15,000.00

The above is a true copy from the books of this office.

HERSCHEL FORD, *Treasurer.*

STATE FUND.

The Maryland Agricultural Experiment Station, in Account with the State of Maryland Appropriation.

DR.

1911.		
July 1—To Cash Balance		$44.99
From State		10,000.00
Interest		22.35
		$10,063.34

CR.

1912.		
June 30—By Salaries	$866.00	
" Labor	2,158.04	
" Publications	1,328.32	
" Postage and Stationery	117.70	
" Freight and Express	303.16	
" Heat, Light and Water	161.51	
" Chemical Supplies	85.38	
" Seeds, Plants and Sundry Supplies	702.01	
" Fertilizers	566.66	
" Feeding Stuffs	564.64	
" Library	98.50	
" Tools, Implements and Machinery	957.84	
" Furniture and Fixtures	72.32	
" Scientific Apparatus & Specimens	36.02	
" Live Stock	40.00	
" Traveling Expenses	882.30	
" Buildings and Land	625.40	
" Exhibits	431.58	
" Balance	55.96	
		$10,063.34

The above is a true copy of the books of this office.

HERSCHEL FORD, *Treasurer.*

HORTICULTURAL FUND.

The Maryland Agricultural Experiment Station, in Account with the State of Maryland Appropriation for Horticultural Investigation.

DR.

1911.		
July 1—To	Cash Balance	$406.42
"	State	4,000.00
"	Interest	23.21
		$4,429.63

CR.

1912.			
June 30—By	Labor	$258.58	
"	Publications	680.92	
"	Heat, Light and Water	64.54	
"	Seeds, Plants and Sundry Supplies	642.35	
"	Fertilizers	65.22	
"	Library	63.25	
"	Tools, Implements and Machinery	15.81	
"	Furniture and Fixtures	12.50	
"	Live Stock	425.00	
"	Traveling Expenses	214.40	
"	Buildings and Land	35.35	
"	Freight and Express	4.20	
"	Postage and Stationery	64.23	
"	Balance	1,883.28	
			$4,429.63

The above is a true copy from the books of this office.

HERSCHEL FORD, *Treasurer.*

Station Farm Account.

Maryland Agricultural Experiment Station, in Account with Station Farm.

Dr.

1911.			
July 1—To	Balance		$467.59
"	Sale of Stock, Produce and Labor		8,605.76
			$9,073.35

Cr.

1912.			
June 30—By	Salaries	$125.00	
"	Labor	4,950.26	
"	Publications	425.18	
"	Postage and Stationery	149.28	
"	Freight and Express	757.00	
"	Seeds, Plants and Sundry Supplies	436.02	
"	Fertilizers	372.50	
"	Feeding Stuff	6.00	
"	Library	17.26	
"	Tools, Implements and Machinery	378.81	
"	Live Stock	855.00	
"	Traveling Expenses	338.97	
"	Contingent Expenses	5.00	
"	Buildings and Land	88.15	
"	Balance	168.92	
			$9,073.35

The above is a true copy of the books of this office.

Herschel Ford, *Treasurer.*

PUBLICATIONS.

The publications of the Station give more or less of a history of the Station's activities and the main results which have been obtained during each fiscal year. This has been the banner year as to number of bulletins issued. The following list shows the subjects, authors and number of pages in each bulletin:

Date.	No.	Subject.	Author.	Pages.
July, ...1911.		24th Annual Report.	H. J. Patterson.	18
July, ...1911.	155	Maryland Weeds.	J. B. S. Norton.	71
Sept., ...1911.	156	Rose Mildew.	J. B. S. Norton. and T. H. White.	3
Sept., ..1911.	157	Some Experiments with Poultry.	C. L. Opperman. and R. H. Waite.	15
Sept., ..1911.	158	Miscellaneous Green House Experiments.	C. P. Close. and T. H. White.	13
Oct., ...1911.	159	Peach Culture.	C. P. Close. and W. R. Ballard.	80
Oct., ...1911.	160	Strawberries.	C. P. Close. W. R. Ballard. T. H. White.	28
Nov., ...1911.	161	Treatment for the San Jose Scale and Terrapin Scale Insects.	T. B. Symons. E. N. Cory. O. G. Babcock.	14
Dec., ...1911.	162	The Quality of Seeds.	J. B. S. Norton.	7
Jan., ...1912.	163	Increasing the Durability of Fence Posts.	F. W. Besley.	20
Feb., ...1912.	164	Lime-Sulfur as a Summer Spray.	J. B. S. Norton. T. B. Symons.	10
Feb., ...1912.	165	Boys' Corn Growing Contest in 1911.	N. Schmitz. W. E. Hanger.	12
May, ...1912.	166	Factors influencing the diffusion and depletion of lime in soils.	L. B. Broughton	42
May, ...1912.	167	Changes in Irish Potatoes during Storage.	C. O. Appleman	10

INVESTIGATIONS IN PROGRESS.

There has not been very many new investigations inaugurated during the past year, as funds would not permit of much expansion of the work and new subjects could only be taken up as pieces of work were completed.

In discussing the work in progress under the different divisions a complete list will not be given but note will only be made of those features which are new or which would seem to be of special interest.

SOIL AND FERTILITY INVESTIGATIONS.

Studies are in progress on the physical and mechanical effects of lime on different kinds of soils. Some demonstrations were started this spring in each county of the State in co-operation with Agricultural High Schools, Granges and Farmers' Clubs on the use of different kinds of lime and sources of phosphoric acid. It is planned to have a Station representative visit these demonstrations during the summer, so as to note the results and discuss the work with the farmers of the community more fully than would be possible by any other means.

A series of tests have been inaugurated on the top dressing of hay grasses with commercial fertilizers to determine the following points:

First—The best combination and amounts of commercial fertilizer when used as a top dressing in the spring.

Second—The conditions which will make spring top-dressing most profitable.

Third—Tests of applications made at different times.

GRAIN AND FORAGE CROP INVESTIGATIONS.

The work with these crops has continued along about the same lines as enumerated in last year's report and consists mainly of breeding, cultural and the testing of varieties. There are nine classes of investigations with corn, five with cow-peas, three classes each with wheat, winter oats, alfalfa, five with sweet corn and one each with vetch, clover, barley, spelt and emmer.

HORTICULTURAL INVESTIGATIONS.

You will note that nearly one-half of the bulletins issued the past year referred to horticultural subjects. These give some idea of the Station's activities in this direction. The lines of investigations as printed in the twenty-third reports are being continued, together with a few extensions of some phases in order to meet the problems which arise from time to time. No one has been appointed to fill the vacancy caused by the resignation of Professor Close, as it seemed best to delay an appointment pending the decision on the plan for reorganizing and expanding the horticultural work of the whole institution. It will be necessary, however, to soon have someone to help in the work, as there are more details than the present force can look after and the breeding work with stone fruits should be extended and pushed vigorously. Some new work in rotating clover with vegetables as a substitute for manure has been started.

The Horticultural equipment is badly in need of facilities for the storage of fruits. There was no opportunity this spring to test the orchard heater for the protection against frost, as all of the buds were winter killed in the available orchards.

Botanical and Pathological Investigations.

Some data had been accumulated for several years on weeds and means for eradicating them and on seed examinations. This matter has been prepared and issued as a bulletin.

The principal work in this department consists of a study of the effect of fertilizers on the cell structure of plants, the relation of feed to plant variations and the effect of chemicals on plant diseases.

Plant Physiological Investigations.

The work outlined in last year's report is being continued. In connection with these studies some data was accumulated on the changes in Irish potatoes during storage, that seems to have a practical application that would be useful to growers. This matter has been prepared and published as a bulletin.

Investigations in Entomology.

The work of this department is largely of an inspection and demonstration character. Many people do not recognize the existence of insect pests and it usually requires a demonstration of the efficiency of sprays to convince them that labor expended in this direction is profitable. The following investigations by this department are in progress:

1. Test of methods for controlling the Terrapin Scale.
2. Test of dipping nursery stock for the control of San Jose Scale and Woolly Aphis.
3. A study of the life history and methods for controlling the Peach Tree Borer.
4. A study of the life history of the Woolly Aphis.
5. A study of the nature and extent of bee diseases.
6. Life history studies have also been begun on the Larger Canna Leaf Roller, the Antique Tussock Moth, the Carolina Poplar Leaf Tyer, a Web Worm and the White Pine Weevil. The Adams Fund study of the Aphidiinae group of parasites has been completed and published as bulletin 152. Work is now in progress on the Opiinae group of parasites.

POULTRY INVESTIGATIONS.

The resignation of Dr. G. E. Gage caused some interruption to the poultry disease studies, but it has been resumed by Dr. B. M. Bolton.

The commercial studies listed in last year's report are being continued and in addition a study is in progress as to the cause of leg weakness in chicks.

The Station poultry department co-operated with the College the past winter, as was done previously, in holding the special one-week poultry course. This department also made exhibits during the year at the following fairs and shows: Pocomoke City, Wicomico, Talbot, Tolchester, Timonium, Hagerstown and Frederick Fairs and at the Baltimore and Washington Shows.

DAIRY INVESTIGATIONS.

The chemical and physical studies of milk are being continued.

Some work is being inaugurated to determine the "Effect of Mechanical Manipulation on the Secretion of Milk" and the "Relation of Physical Structure to Milk Secretion."

DAIRY DEMONSTRATIONS AND EXTENSIONS.

Considerable has been done during the past year in co-operation with the United States Department of Agriculture toward calling the attention of the dairy interest to the need of improved methods. This work is being done in co-operation with the Dairy Division of the United States Department of Agriculture. They assign a man to Maryland to work under our direction. The following are the lines of activity on this subject:

1st—Gave 20 talks on dairying at Farmers' Institutes.

2nd.—Gave 30 talks on dairying at Farmers' Clubs, Granges and picnics.

3rd—Gave course of six lectures and helped in judging work with short-course students.

4th—Gave butter-making demonstration at Hagerstown Fair.

Fifth—Supervised Young Men's Cow-Judging Contest at Hagerstown and Laurel Fairs.

6th—Supervised Dairy Exhibit of State Dairymen's Association at Maryland Week Show.

7th—Visiting over 100 dairy farms and gave advice on improving Dairy Conditions.

8th—Assisting farmers in planning, remodeling and constructing dairy barns and silos.

9th—Organized a circuit or co-operative Guernsey Breeders' Association at New Windsor.

10th—Organized Cow-Testing Associations in Baltimore, Harford and Cecil Counties.

11th—Organized and supervised State Contest of Dairy Cows.

12th—Supervising tests of Cows for Advanced Registry.

The results from most of this work is very gratifying; for instance, as a result of keeping records and weeding out of his dairy herd, one farmer sold $225 more produce from 16 cows in eight months in 1911-1912 than he did from the same number in 12 months in 1910-1911.

I recommend that this class of work be continued and extended as much as possible.

DEMONSTRATION WORK.

There is a great demand for demonstrating better farm methods in every phase of Agriculture. This demand comes from many parts of the State. The opportunities for doing good by this class of work are very great and should be embraced as largely as possible. There is an urgent need for demonstration work in spraying and packing fruit; in fertilizing and growing the staple crops; and in the selection, feeding and care of dairy stock, and I would recommend that the special appropriations for demonstration work be expended equally along these three lines.

In this connection I would suggest that the custom of having farmers visit the College and Experiment Station and see the work in progress be resumed and extended. I believe that 10 to 15 days during the summer could be profitably devoted to such work.

By grouping the State into districts according to transportation facilities and making special arrangements with the Railroads for excursion rates a lot of farmers should be brought in direct touch with the work of the Institution to their mutual advantage.

In entertaining these farmers I would suggest adopting the plan followed so successfully at the Guelph College—of giving a lunch of sandwiches and coffee. This would reduce the expense and not consume as much of the time of the visitor as a regular dinner would.

Farmers don't realize the progress this Institution has made or the amount of work going on and the best way to have them fully appreciate it is to have them come and see for themselves.

NEEDS OF THE STATION.

Many lines of work are much curtailed and circumscribed for the want of suitable land. Much more land could be profitably used and will be more and more of a necessity in the future. For the greatest usefulness the land should be located as near the Institution as possible and as suitable land is becoming scarcer and higher in price I would suggest that the Agricultural Committee look into this matter at an early date. I believe that a feasible plan that would not be burdensome could be devised to finance the purchase of some land.

The Station needs better arrangements for housing implements and some rearrangement of the stabling would facilitate operations.

We have some lumber on hand that could be used for part of this work and I would recommend that these changes be made to such an extent as present funds will permit. Some rearranging of the buildings may permit us to take care of the manufacture of hog cholera serum to better advantage than could be done by the construction of new buildings I would recommend that this matter be referred to the Agricultural Committee for consideration and action.

Appended herewith I will submit some recommendations to the State Board of Agriculture.

RECOMMENDATIONS FOR THE CONSIDERATION OF THE STATE BOARD OF AGRICULTURE.

Gentlemen:—By Legislative enactment the Board of Trustees of the Maryland Agricultural College is ex-officio the State Board of Agriculture and the Director of the Experiment Station is the Secretary of the Board. The only specific work done so far in the name of the Board was to make an exhibit at the Pittsburg Land Show in the fall of 1910. The last Legislature passed two important laws that have been put in the hands of the Board of Agriculture for Administration.

1st—The Seed Inspection Law.

2nd—The law for the establishment of a Biological Laboratory for the manufacture of Hog Cholera Serum and other biological preparation for use with domestic animals.

The appropriation made by these acts will not be available until after October 1, 1912.

I would offer the following suggestions with reference to plans for putting these measures into operation.

SEED INSPECTION.

The act providing for seed inspection makes an annual appropriation of $2,000 for the work. In the beginning the work will probably not command the entire time of one man throughout the year and at the suggestion of Professor Norton, our Botanist, I recommend that the position of Seed Analyst be combined with that of teacher of Botany in the College, as the work of these two can be conducted together satisfactorily, and this plan would be mutually helpful, as it would enable both sides of the work to avail of a higher class of men than could be done otherwise.

As the Seed Inspection work will be required largely during months of August, September, February and March, I would suggest that arrangements be made so that the farmers be able to avail of this help this fall and not wait until after October to start the work.

STATE BIOLOGICAL LABORATORY.

This act carries an appropriation of $5,000 for the equipment and $5,000 for 1913 and $5,000 for 1914 for maintenance.

Calls for serum are beginning to come in, and in order to provide for these until we can manufacture it, I would recommend that we purchase some as need from either the Kansas or Michigan Stations, as they have offered to supply us. The law provides that this serum shall be sold to farmers and administered under our direction at cost. This will permit us to provide for this temporary supply without any expense to us.

In order that the work may be planned for with the greatest facility and harmonized with the work of the Experiment Station, I would recommend that the details be referred to the Agricultural and Station Committee of the Board of Trustees for execution and supervision.

We have some lumber on hand that could be used for part of this work and I would recommend that these changes be made to such an extent as present funds will permit. Some rearranging of the buildings may permit us to take care of the manufacture of hog cholera serum to better advantage than could be done by the construction of new buildings I would recommend that this matter be referred to the Agricultural Committee for consideration and action.

Appended herewith I will submit some recommendations to the State Board of Agriculture.

RECOMMENDATIONS FOR THE CONSIDERATION OF THE STATE BOARD OF AGRICULTURE.

Gentlemen:—By Legislative enactment the Board of Trustees of the Maryland Agricultural College is ex-officio the State Board of Agriculture and the Director of the Experiment Station is the Secretary of the Board. The only specific work done so far in the name of the Board was to make an exhibit at the Pittsburg Land Show in the fall of 1910. The last Legislature passed two important laws that have been put in the hands of the Board of Agriculture for Administration.

1st—The Seed Inspection Law.

2nd—The law for the establishment of a Biological Laboratory for the manufacture of Hog Cholera Serum and other biological preparation for use with domestic animals.

The appropriation made by these acts will not be available until after October 1, 1912.

I would offer the following suggestions with reference to plans for putting these measures into operation.

SEED INSPECTION.

The act providing for seed inspection makes an annual appropriation of $2,000 for the work. In the beginning the work will probably not command the entire time of one man throughout the year and at the suggestion of Professor Norton, our Botanist, I recommend that the position of Seed Analyst be combined with that of teacher of Botany in the College, as the work of these two can be conducted together satisfactorily, and this plan would be mutually helpful, as it would enable both sides of the work to avail of a higher class of men than could be done otherwise.

As the Seed Inspection work will be required largely during months of August, September, February and March, I would suggest that arrangements be made so that the farmers be able to avail of this help this fall and not wait until after October to start the work.

STATE BIOLOGICAL LABORATORY.

This act carries an appropriation of $5,000 for the equipment and $5,000 for 1913 and $5,000 for 1914 for maintenance.

Calls for serum are beginning to come in, and in order to provide for these until we can manufacture it, I would recommend that we purchase some as need from either the Kansas or Michigan Stations, as they have offered to supply us. The law provides that this serum shall be sold to farmers and administered under our direction at cost. This will permit us to provide for this temporary supply without any expense to us.

In order that the work may be planned for with the greatest facility and harmonized with the work of the Experiment Station, I would recommend that the details be referred to the Agricultural and Station Committee of the Board of Trustees for execution and supervision.

THE MARYLAND AGRICULTURAL
EXPERIMENT STATION

BULLETIN No. 155. AUGUST 1911.

MARYLAND WEEDS AND OTHER HARMFUL PLANTS.

By J. B. S. Norton.

"Thorns also and thistles shall it bring forth."

SUMMARY.

This bulletin contains (1) general information on the nature of weeds, their habits of life, how they are injurious to agriculture and to what extent; (2) the agricultural types of weeds and methods of management for each type, and (3) for each species separately; and (4) a list of the principal weeds of Maryland is given, and (5) a key for distinguishing them.

(6) Experiments in eradication of weeds by spraying with iron sulfate and (7) with dissolved fertilizers, (8) on the killing of trees and bushes with chemicals and (9) on the effect of different fertilizers on weeds in meadows are recorded, also (10) some experiments on the action of chemicals in weed killing, and the variation in such action under different weather conditions.

The importance of (11) pure seed regulations and (12) the teaching of children in the common schools to recognize weeds and weed seeds, is emphasized. Lists of (13) poisonous plants and of (14) cultivated plants which may become injurious are also included. Some determinations of the (15) number of seeds per pound of different species is given in the table on page 4.

INTRODUCTION.

Though the weed problem was one of the very first presented to the primitive agriculturist, it is still of interest to every farmer. The large number of inquiries about weeds coming to this Experiment Station annually is sufficient reason for the publication of this bulletin. It records knowledge that has been acquired from several years' general work with Maryland weeds and their control, incorporated with information from various other sources. Some recent experiments in the use of chemicals in weed killing are also given.

The publications of the United States Department of Agriculture; Bulletin 175, Ohio Experiment Station; Bulletin 260, Michigan Station; Bulletin 70, Iowa Station; Bulletin 80, North Dakota Station;

H. C. Long's Common Weeds of Farm and Garden; Bailey's Cyclopedia of American Agriculture and many other publications have been consulted and matter from them used when it could be applied to Maryland conditions. The most of the illustrations were obtained through the kindness of the Michigan and Ohio Experiment Stations, and were previously published in their bulletins 260 (Beal) and 175 (Selby) respectively. Plate VIII is republished from Bulletin 100 (Norton and Walls) of this Station.

THE NATURE OF WEEDS.

Under the term plants may be included all living things except the animals. The earth is so covered with them that perhaps 90 per cent. of all we see when we look out over the landscape is composed of vegetable matter. Trees cover the ground in the forests and herbaceous plants in the plains and fields. The water is filled with water plants, the air and every exposed place and even the interior of animals and other plants is often crowded with bacteria and other minute plants. Man looks upon them all from the standpoint of their relation to his welfare. All plants that interfere with his operations or grow where he does not want them are called weeds, in the broad sense. This would include the natural vegetation on uncleared land, the fungi that live on cultivated plants, the bacteria that attack our bodies, etc. But the term weed, is usually limited to those herbaceous plants that owing to their adaptability to a variety of conditions, a life cycle similar to that of cultivated plants, tenacious hold on life, abundant propagation or easy seed dissemination are especially fitted to succeed well in cultivated land.

We must look upon weeds in this sense as the highest type of plants, as they are certainly the most successful in maintaining life, propagating their species, and invading new territory, often against the most strenuous efforts of man to prevent them. The more successful they are, the more dangerous to other plants.

Any plant may become a weed; for example, buckwheat and rye among other crops. The crop itself is the worst of weeds when it is too thick.

DAMAGE DONE BY WEEDS.

How well founded is the long standing aversion to weeds, which we have acquired? Some weeds, for example, crab-grass, ripple, pursley and sweet clover, make desirable or nutritious animal foods. Weeds add vegetable matter to the soil, and it cannot be denied that they are a benefit to our abandoned fields. They serve the purpose of a cover crop when none can be sown; they feed the birds, especially in winter; and if nothing else, they taught us tillage, with all its benefits, by our first efforts to get rid of them.

But the presence of weeds in a cultivated crop, aside from its indication of poor farming, certainly reduces the yield, as (1) they rob the crop of moisture, and water has a more marked influence upon growth than any other factor; (2) they use up other valuable elements of the soil; (3) they crowd the plants of the crop out of space and light, the broad leafed weeds like plantain and mustard being particularly bad; (4) their presence as an adulterant in the harvested product may reduce its quality and price; (5) they may harbor injurious insects or fungi (weeds of the mustard family may carry club root or black rot, etc.; horse nettle, ground cherry, nightshade, etc., may be subject to the same diseases as potato and tomato; wild cherry is infected with the black knot of plum and cherry; cedars carry the apple rust, etc.); (6) they may be poisonous or injurious to man or domestic animals; (7) they interfere with harvesting, especially such weedy vines as morning glories and bindweeds; (8) they may prevent the drying of hay or grain in the shock; (9) the additional labor and expense of handling them with the harvested crop is a loss; (10) they may interfere with the system of rotation.

It would be difficult to accurately estimate the actual financial loss due to weeds. It is certain that the money value of the labor expended in combatting them is enormous. The cost of removing the weeds along the railroads in Ohio is given by Stair at over half a million dollars annually. The annual cost of keeping 100 acres clean in Ontario was found to be about $75.00. The annual dockage on grain in Minnesota as given by their State Grain Inspection Department, amounted to a total loss to the State of $2,500,000, chiefly on account of weed seeds. Pammel estimates the loss from weed growth in Iowa at five to seven million dollars annually, on the basis of an experiment showing one-third larger crop on clean land. European experimenters (see Long, Common Weeds, p. 15) show a loss of 30 to 50 per cent. of the crop value from the presence of weeds.

Possibly the effort taken to get rid of some conspicuous weeds on the farm is greater than the loss their presence occasions. Some experiments to show the varying reduction of crop values from different species of weeds and the varying cost of eradicating different kinds would give us a basis for work with weeds which we do not now have.

HABITS OF WEEDS.

The habits of life, growth and propagation of a weed, determine the methods of its control; so the intelligent farmer should know the characteristics of the weeds he has to contend with.

Many weeds (annuals) grow from seed each spring or summer and do not survive the winter. Others (winter annuals) germinate in summer or autumn, live over winter and mature and die the next year. Plants of these two kinds depend for propagation chiefly upon the abundance of seed they produce. Most of our ordinary annual weeds, if well developed, will produce from 10,000 to 1,000,000 seeds per plant, and some of these are so small that a pound of clover or grass seed might contain thousands of them without appearing very bad. The following table indicates the relative size of the seeds of some weeds and other plants. The figures show the number of seeds in one pound of the kind named.

Cocoa nut (*Cocos nucifera*)	½
Japanese chestnut (*Castanea japonica*)	43
White oak (*Quercus alba*)	205
Broad bean (*Vicia Faba*)	290
Lima bean (*Phaseolus lunatus*)	298
Corn (*Zea mays*)	1,808
Soy bean (*Glycine hispida*)	2,720
Cow pea (*Vigna sinensis*)	3,296
Yellow lupine (*Lupinus luteus*)	4,528
Great ragweed (*Ambrosia trifida*)	10,000
Wheat (*Triticum sativum*)	11,650
Vetch (*Vicia sativa*)	12,240
Morning glory (*Ipomoea hederacca*)	16,500
Sainfoin (*Onobrychus sativa*)	20,860
Cockle (*Angostemma Githago*)	57,000
Jimson weed (*Datura Tatula*)	66,000
Johnson grass (*Sorghum halepense*)	105,760
Crimson clover (*Trifolium incarnatum*)	132,000
Alfalfa (*Medicago sativa*)	226,500
Mallow (*Malva rotundifolia*)	237,000
Rye grass (*Lolium perenne*)	240,400
Poison hemlock (*Conium maculatum*)	257,000
Sweet clover (*Melilotus alba*)	271,000
Red clover (*Trifolium pratense*)	272,000
Millet (*Setaria Italica*)	272,160
Black medick (*Medicago lupulina*)	285,000
Japan clover (*Lespedeza striata*)	420,890
Sheep's fescue (*Festuca ovina*)	498,960
White clover (*Trifolium repens*)	830,000
Crab grass (*Digitaria sanguinalis*)	1,088,000
Blue vervain (*Verbena hastata*)	1,909,000
Pigweed (*Amaranthus retroflexus*)	2,260,000
Moth mullein (*Verbascum Blattari*)	4,372,000
Shepherd's purse (*Capsella Bursa-pastoris*)	6,496,000
Begonia (*Begonia species*)	66,607,000
Adam-and-Eve (*Aplectrum hyemale*)	247,365,000

Annual weeds are easy to control by cultivation and if prevented from seeding have no means of reappearing except from old seed in the soil. Examples are crab grass, pigweed, foxtail, ragweed, smartweed, lamb's quarters. The biennials such as wild carrot are similar except that they vegetate one summer and seed and die the next.

The perennial weeds, which live over winter from year to year either above or mostly below ground are often very difficult to eradicate, as the underground propagating stems or roots contain a supply of nutrient material for renewing the growth when the top is killed and often spread the plant from year to year by their further growth.

Examples of perennials with rootstocks so abundant as to form a sod are Bermuda grass and couch grass. Others with running rootstocks or propagating roots are sorrel, Canada thistle, nut grass and horse nettle. Those which renew the plant in spring, or when injured, from buds on a central crown or single rootstock are less difficult to manage. Examples are dandelion, plantain and ripple.

In almost all cases weeds get from field to field by means of seeds which are carried in the seed of the crop sown, as in the case of dodder; or are carried by wind through the air as dandelion, lettuce, white-top, etc.; or blown along the ground, as some of the small light seeds are. In high winds even the heavier seeds are carried long distances along the ground or in drifting snow. They may also be carried to lower areas by water; or like cocklebur, Spanish needles, etc., may stick to animals which desseminate them.

Much weed seed is carried into fields in manure. They come from the bedding material or may pass through the animals without losing vitality as is shown by Oswald in Bulletin 128 of this Station. The seeds are killed, however, if the manure stands in piles for a time before going on the land, but the value of the manure is reduced by the fermentation.

New weeds are often found along railroads and near boat landings where they have come in in various ways from other places.

One of the most important facts with reference to weed propagation is the remarkable vitality of seed in the soil. If buried too deep for germination they may remain alive for many years and then germinate when uncovered. Bolley found that some mustards live in the soil for 4 or 5 years without any special protection, but that most seeds die in one or two years if not kept dry.

Many weeds while growing to some extent in different kinds of land are especially adapted to certain conditions. The following are examples of some adapted to certain types of soil:

Weeds of light land,—sandbur, sorrel, ripple.

Weeds of poorly drained land,—barnyard grass, foxtail, sedges, dock, great ragweed, Spanish needle.

Weeds adapted to cultivated land,—lamb's quarters, pigweed, mustard, morning glory.

Weeds of paths and yards,—yard weed, yard grass, slender rush.

AGRICULTURAL TYPES OF WEEDS.

The species of weeds present or injurious as well as the methods of weed control to be used, depend on the crop or method of cultivation. We may distinguish the following types of weeds from the agricultural standpoint:

1. Weeds of cultivated fields.
2. Grain weeds.
3. Grass land weeds.
4. Garden weeds.
5. Greenhouse weeds.

6. Orchard weeds.
7. Lawn weeds.
8. Waste land and roadside weeds.
9. Woodland weeds.
10. Marsh and ditch weeds.
11. Weeds obstructing water courses, ponds, etc.

In cultivated fields and gardens the ordinary operations of cultivation with the use of the hoe if necessary is the main dependence for weed control.

In grain and grass lands one must depend on clean seed, clean cultivation of the previous crop, thorough preparation to secure a perfect stand and proper use of fertilizers to get a vigorous growth of the crop to outgrow the weeds. A system of farming which allows plowing and harrowing between grain and grass is a strong point in keeping down weeds. Harrowing grass and grain fields in the spring is used to give the grass a better start and kill out young weeds. Mowing in summer prevents the weeds from seeding so abundantly. In some cases special methods must be used for certain weeds, for which, see the discussion of the particular weed given later in this bulletin. In pastures, mowing, the spud or hoe, or salt and sheep can be used for scattering weeds or small patches.

The weeds of waste land and roadsides are usually kept under control by mowing, or burning when it is practicable. The same would apply to woodland if it is thought best to deal with it. Goats are often used to clean up waste or wood land or to aid in clearing new ground.

Cultivation, or if it is not desirable, mowing before seed production is advised for orchard weeds.

The weeds of wet land usually disappear upon drainage and cultivation, though some may persist for years. Some of the weeds, especially the water scums in ditches, streams, etc., can be killed by small quantities of copper sulfate added to the water, but it must be used with caution, and not when there is danger to fish.

Weeds in lawns can usually be kept down by frequent reseeding, close cutting, and good fertilizing, or top dressing with clean manure in winter.

METHODS OF WEED CONTROL.

As has been indicated methods of weed contiol depend upon the character of the weed to be attacked and upon the farm practice that must be used for other reasons; also upon whether the value of the crop will make the method practical. Some of the different means of control will now be given and the kinds of weeds to which each applies. Under the descriptions of the various species of weeds will be given the special methods applicable to each.

The general practices to be observed are: Clean cultivation, short rotations, watchfulness against introductions in seed, and quick eradication of new kinds that appear.

The problem is not a light one, and no device will save much hard labor if weeds are to be kept down.

CLEAN CULTIVATION.

Destroying weeds during the process of tillage, whether with hoe, cultivator, plow or harrow not only removes the weeds themselves but to be effective must kill them before seed is produced. A few plants such as pigweed, pursley or white-top left to attain full size will produce millions of seeds. And it must be remembered that many weeds (cocklebur, carrot, crab grass) if cut off, produce new shoots near the ground and mature sufficient seed to restock a field the next year.

One of the greatest difficulties to contend with in weed eradication is the ungerminated, viable weed seeds buried in the soil. Keeping the land clean for one year is by no means sufficient to eradicate the weeds. One advantage of cultivation is to stir up the buried seeds and induce them to germinate during the cultivating period. Plowing, allowing the buried seed to sprout and then harrowing, or giving more than one harrowing, with time for germination between, before putting in the crop, will get rid of an immense number of weeds. Germinating and killing as many weeds as possible before sowing is especially valuable in case of alfalfa which is often much injured by weeds before it can get a start. If land is very weedy this plan should be followed with wheat stubble and grass sown afterward.

Harrowing grain as soon as it becomes well rooted, and while weeds are still in the seed leaf will do much to prevent weedy fields, as it not only kills the young weeds but makes the soil conditions better for the grain.

In some places bare summer fallowing is practiced for cleaning up old weedy land, but the same end can be attained except with some perennial grasses like couch grass and Bermuda grass, and often with these, if some crop which can be kept absolutely clean the whole growing season is grown. It is best to grow some crop that does not cover the ground and hide weeds as potatoes, tomatoes, etc., do late in the season. Corn is an ideal crop for the purpose but is apt to be neglected on account of difficulty in cultivating the last half of the season, which is the critical time for weed seed production. Cultivation must be kept up till the autumn frosts if annuals are to be kept from seeding and perennials starved out.

The ordinary cultivator shovels are not designed for the best weed killing as they slip around tough stems and roots. A broader instrument of the weed killing type is better.

Prevention of seeding whether by cultivation, mowing or spraying, will, at least, after a few years have brought to germination the dormant seeds in the ground, subdue the annual and biennial weeds, and prevent the spread of the perennials to new locations.

ROTATIONS.

One of the most important reasons for crop rotations is that the accumulation of weeds in grass land may be destroyed during cultivation of the following crop. Also when the land is in grass many of the seeds of the annuals of cultivated land decay. If the rotation does not keep down the weeds it is not a good one. Meadow weeds such as couch grass, ox-eye daisy, buttercup and white-top do little harm in a one or two year rotation.

CLEAN MANURE.

All manure and other materials containing dangerous weed seeds to be put on fields should be first composted. Many mill feeds as well as weedy hay contain large numbers of weed seeds. The Vermont Experiment Station has found molasses feeds especially rich in live weed seeds. The silo is a good means of insuring clean manure as the vitality of weed seeds in ensilage is destroyed by the fermentation process.

MOWING AND BURNING.

Roadsides should be kept clean of weeds for esthetic reasons if not for preventing seed dissemination. Mowing off weeds from stubble, grass fields, etc., to prevent seeding will keep down many weeds. In general, the best time to weaken the underground parts of perennials by mowing, is to cut them when the plant is exhausting itself in flower and seed production but before seed is ripe. Pursley, dock, winter cress and others contain enough water to mature seed after being cut, if in bloom then.

STARVING OUT.

Perennials that propagate by underground parts, for example: Canada thistle, horse nettle, couch grass, garlic and other bulbs, can in most cases be exhausted by continually keeping all parts above ground destroyed. No new material for growth can be added to the plants except through the green parts, and if these are destroyed the supply underground is used in the effort to make new foliage, until after a time the most persistent kinds will exhaust all their reserve and die. It may take several years with some species, but is the surest method with most of them.

The purpose may be accomplished best by use of the hoe or spud, and must be repeated as often as new shoots appear above ground. Labor may be saved by cutting as deeply under the surface as possible, so that it takes longer for the new shoots to reach the surface, but remember that they may come up next day from other underground shoots that were not visible before. Special methods of plowing accomplish much in this way, and sprays will sometimes keep the stems down below the surface; but nothing comes up to constant vigilance with a hoe or spud. Salting and sheep are effective in pastures. The important thing is to let no green colored parts form. If a patch of Canada thistle is carefully kept cut back for a while and then neglected the labor is lost.

This method is especially valuable with new perennial weeds that are just getting a foothold, and of course must give way to other treatment where large fields are infested throughout. One common reason for failure of this method is that even when pursued with vigor during spring and summer slackened vigilance in the fall allows the weed to re-establish itself.

SMOTHERING CROPS.

The growing of a heavy, dense cover of some crop such as rye, millet, buckwheat, cowpeas or crimson clover, that will outgrow the weeds and deprive them of light. water and fertilizer. is another valuable method of starving out persistent perennials. It is best alternated with a cultivated crop in summer. A good method is rye, winter oats or crimson clover in winter, followed by thorough plowing and harrowing and a clean hoed crop or a summer smothering crop of millet, buckwheat or cowpeas. Corn or sorghum are valuable smothering crops.

Beal recommends tarred paper for smothering out small patches of such weeds as Canada thistle. This or boards can be used on blue grass lawns, if carefully managed, without killing out the grass as it remains alive longer than most lawn weeds.

DRAINAGE, ETC.

Weeds that occupy only certain kinds of soil or situations can best be controlled by changing the conditions. This applies particularly to weeds of wet ground, which disappear upon drainage.

FERTILIZERS.

Weeds that flourish in sterile soil can be crowded out by the use of fertilizers. Different fertilizers are more favorable to some plants than others and much good in weed control may come from a proper study of this fact, but little can be given as yet.

In English experiments (Jour. Board, Agric. Vol. 7) nitrate of soda with phosphate was found to have a repressing influence on agrostis, ripple and legumes. Alone the nitrate encouraged an inferior type of herbage. Sulfate of ammonia produced more agrostis and ripple. Superphosphate reduced the percentage of agrostis and orchard grass. Kainit increased the growth of legumes and repressed the agrostis. Lime increased the ripple and reduced the agrostis and orchard grass.

In general the Rothamstead conclusions were that nitrogen combined with mineral fertilizers encouraged the stronger grasses and crowded out the weeds.

Potash and phosphate without nitrogen is said to lessen ox-eye daisy.

"Lawn sand," or sulfate of ammonia mixed with fine dry soil is used with great success in England for clearing lawns of plantain, etc. (Long, p. 345). One-half to one ounce of sulfate of ammonia per square yard is used.

The main effect of liberal use of manure and fertilizers is to invigorate the crop so it will outgrow many small weeds like sorrel and plantain, which would predominate in short grass. In general weedy grass is an indication that the land is poor.

EXPERIMENTS WITH FERTILIZERS.

In the fall of 1909 several rod square plots were staked off from a meadow one or two years old and treated with various fertilizers, etc., and, while the plots were too small to draw exact conclusions from, the results indicated in the table on page 11 were obtained.

The percentage of weeds is rather low on all the plots and does not vary much. In looking over the field it had the general appearance of being rather weedy, the ox-eye daisy and white-top showing up conspicuously. But on all the plots the weeds average only 2.4%. On the four best plots the percentage of weeds averages 3.6, running up rather high on the potash. The lower average of the total is accounted for partly by the weeds being almost entirely killed out on the iron sulfate plots; but the growth of grass and clover was also low there.

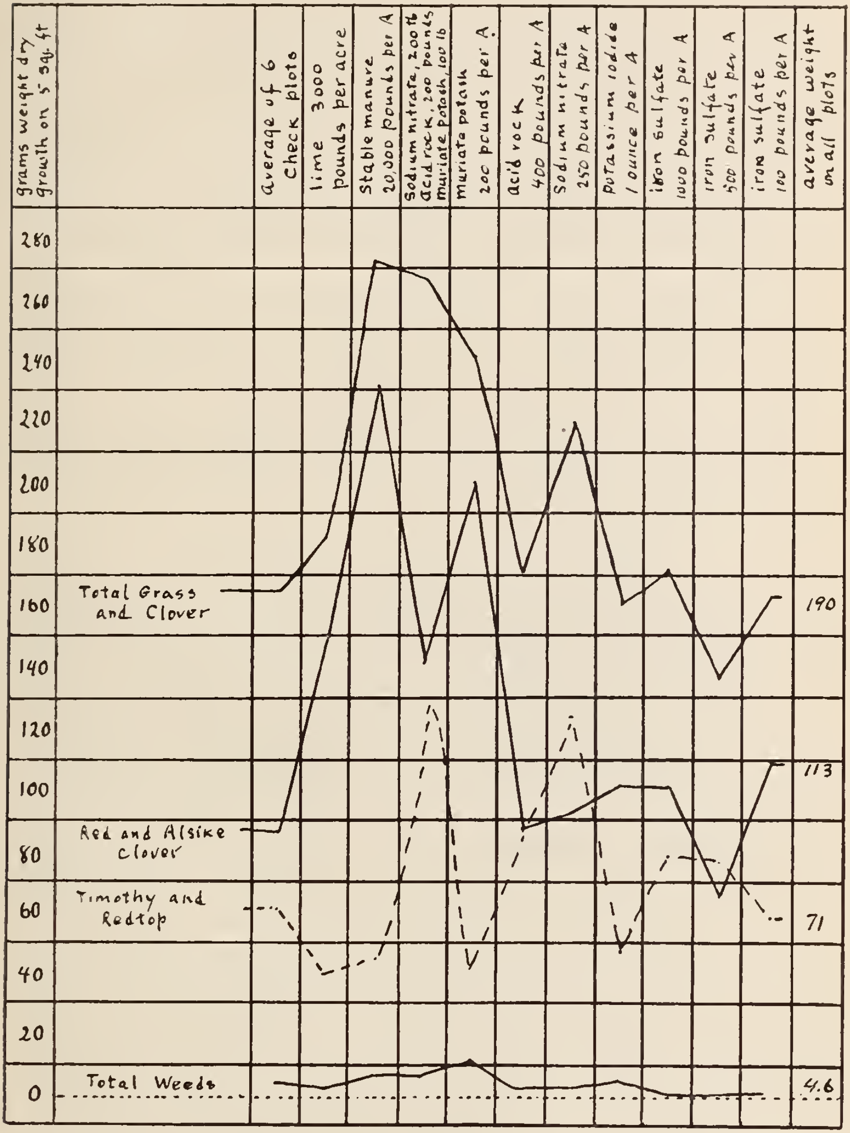
In general, the weeds vary but little while the variation in grass and clover with the different treatments is very marked.

It may be mentioned that a mixture of various weeds was sown on these plots in the fall of 1909, but none of these made any showing in the next summer's cutting. The weeds present were in order of their weight: ox-eye daisy, ripple, plantain, white-top, yarrow, sorrel, horse nettle, wild carrot, ragweed.

SPRAYING.

Some plants are more easily killed than others by certain chemicals. This fact has in recent years been utilized on a large scale, especially in the grain regions of the northwest, for killing mustard and other weeds in grain fields by spraying with a strong solution of iron sulfate or other substance. The principle can be made use of in many ways.

Some experiments have been conducted here along this line for the past two or three years and the iron sulfate was found of value especially in controlling chickweed and other early weeds in strawberries, alfalfa, etc. It can best be used in the dormant season, preferably after frost in the fall when the weeds are small, and probably less injury would be done to the crop and recovery be made without loss of time. The iron sulfate is used at the rate of 1½ to 2 pounds per gallon of water. The material used in our experiments was the granulated form supplied for trial by the American Steel and Wire Company.



The good results obtained in the dryer climate of Minnesota, Dakota, etc., cannot be expected here, and if rain falls in 18 hours the work may have to be done over; the spray, however, seems to do best on dark damp days without rain. It is necessary to use a good traction sprayer that will make a very fine spray and apply it with considerable force.

Of course, some crops would be injured just as much as the weeds; but most grasses and grains are less injured than other kinds of plants, while in general the plants of the mustard family are very easily killed. Clovers are injured some but generally recover. One must also bear in mind the possible effect upon the soil of adding large quantities of chemicals from year to year; and if used on lawns remember that iron sulfate discolors walks, clothing, etc.

On walks, roads, fence rows, tennis courts, etc., or on individual plants in lawns and fields, chemicals can be used stronger, even so as to prevent any growth of plants, at least for a time, on the treated soil.

Salt applied dry or in strong brine, and best in hot dry weather is a common, effective, and cheap treatment, and does not render the soil permanently sterile as arsenic compounds do. The latter (sodium arsenite is preferred) are very effective as weed killers, but remain in the soil a long time as poisons dangerous to animal life as well as vegetable.

One of the best applications for walks, courts, etc., is crude carbolic acid, 1 quart in 8 gallons of water to each square rod, making one or two applications per year.

EFFECT OF IRON SULFATE ON DIFFERENT SPECIES.

The following list is made up from observations on sprayed fields on the Experiment Station farm (N), from the summary of various investigations reported by Horton in Farm Weeds, Nov. 1909 (H), from Pammel's list in Bulletin 105, Iowa Station (P), and Adams' list in Bulletin 133, Rhode Island Station (A).

O indicates injury slight or none; K, plants usually killed by the spray; Y, only young plants killed; B, badly injured but not killed; S, seriously injured and later fully recovering or even surpassing unsprayed plants.

Useful plants: Alfalfa, slight (N), beans O (H), B (in Europe), beets B (H), begonia B (N), carrot O (H), celery O (H), cabbage B (H), cucumber B (H), crimson clover O (N), cowpea B (H), B to K (N), corn slight (N), grape slight (N), grasses and grains generally O (H, P, N) (orchard grass not hurt at all, blue grass some injury, N), horse radish B, but fully recovers (H), kale B, but fully recovers (H), millet S (H), melons B (H), mustard B or K (H), oyster plant O (H), onion (small) O (H), onion (large) B (H), parsley O (H), parsnips B (H), peas B (H), peppers B (H), potatoes B (H and others), radish B or K (H), red clover B (P), slight to B (N), spinach S (H), strawberry S (H, ripened later), old leaves K, young O (N), tomato S (H, ripened later), tobacco B (H, recovers perfectly), turnip B (H), Virginia creeper O (N), white clover B (P).

Weeds: Wild carrot O (H), B (N), bindweed (Polygonum) B (H, P, N), burdock O (H), B (P), butter and eggs O (H), chicory O (H), yardweed O (H), B (P, N), lamb's quarters O (H, N), mouse-ear chickweed O or B (H), B (A), black mustard O (H, N), at least B (A), poison ivy O (H, A, N), couch grass O (H), yarrow O (H, A), stick-tight Y (H, N), Spanish needle Y (H), bindweed (*Convolvulus sepium*) K (H), very B (N), buttercup K (H, A), chickweed K (H, A), K unless too thick (N), sweet clover K (H), cocklebur K (H, N), ox-eye daisy (small) K (H, A), slight injury (N), dock Y (H), B (P, N, A), bedstraw K (H), ground ivy K (H), dead nettle K (H), horseweed K (H, N), jimson Y (H, N), great ragweed Y (H, N), paspalum B (N), smartweed B or K (H, N, P), dog fennel Y (H), B (P), black medick K (H), slight (P), charlock K (H, A, N), tumbling mustard B or K (Bolley), peppergrass K (H, N), B (P), pigweed K (H, N), ragweed Y (H, A, N), older ragweeds B (H, N), B or K (P), great ragweed (large plants) B (H, P, N), ripple Y (H), B or K (P), B (N), sorrel B (H, A), killed to the ground very quickly (N), Shepherd's purse K (H, A), Canada thistle, if repeatedly sprayed, B or K (H), whitlow grass K (H, N), dandelion B or K (Bolley), B (P, N), cockle B (H), cinquefoil B (H), Y (A), white-top B (H), plantain B (H, P, A), slight (N), poppy B (H), pursley B (H, P), slight (N), thistles B (H, P), yellow oxalis K (P, N), mosses K quickly (N), lichens on trees, if killed did not show any easily seen change (N), crabgrass O (P, N), nimble Will O (P), three-seeded mercury D (P), velvet leaf B (P), O (N), yellow foxtail B (P), mallow B (P), O (N), carpet weed K (N), briars O (N), St. John's-wort O (N), wax weed B (N), morning glory O (N), buttonweed K (N), honeysuckle slight (N), corn chamomile K (N).

Horse nettle in our experiment was killed in the terminal portions, but well developed leaves and stems were not.

Winter cress was sprayed in the field in 1908 without success; in greenhouse tests in damp atmosphere it was entirely killed the dead plants giving off a strong, peculiar odor.

If plants are injured by insects, mowing, etc., the spray is much more effective.

EXPERIMENTS WITH FERTILIZER SPRAYS.

We have also tested with success a spray of dissolved fertilizers, using such soluble fertilizers as might be of value to the land. Nitrate of soda is best of those tried but is expensive, and if used alone in sufficient strength gives too much nitrogen for the land. A mixture of 1¼ pounds kainit and ½ pound nitrate of soda per gallon is probably better and was used in all the later tests. Salt is equally or more effective but does not have the fertilizing value. With either iron sulfate or the fertilizers at least 50 gallons per acre applied as a fine spray is necessary. The fertilizers or salt work better in dry weather as they seem to act chiefly by drawing water from the foliage and allowing the leaves to dry up. The iron sulfate may operate similarly but seems to also act as a poison.

The following list shows the effect of the nitrate of soda-kainit spray under favorable conditions on different crops and weeds in our experiments.

Cultivated plants: Red clover, badly injured; most grasses, only the outer leaves killed, orchard grass less than the others; apple, slight injury to leaves; strawberry, very slight; sweet potato, leaves half dead; asparagus, not injured; Irish potato, injury slight.

Weeds: Paspalum, crab grass, yellow foxtail badly injured; the vitality of seeds of these grasses was much reduced as determined by germination tests. Stick-tight, cocklebur, ox-eye daisy, fireweed, wild lettuce, oxalis, pigweed, mullein, white-top, and great ragweed were killed by the spray. Ragweed and button weed are quickly and easily killed. Spanish needle, sassafras, yarrow, aster, ripple, smartweed, honeysuckle, horse nettle, wild carrot, dandelion and sorrel had the exposed parts killed but recovered; when sprayed among grasses the latter overcame them. Milkweed, mallow and morning glory, were only partially injured. Plantain was often completely killed in dry weather, but recovered when sprayed in damp weather. Blackberries were almost killed. Poison ivy leaves were killed and in very favorable cases the vines, but some plants sprayed under the shade of trees, were scarcely injured. Yard weed was not entirely killed. Chickweed was killed when not too thick. Lamb's quarters, everlasting and day flower (wild wandering Jew) were not injured.

Sprayings made with the nitrate of soda-kainit sprays on grass fields in the hot dry summer of 1909 killed almost everything except the grasses, the clovers being almost destroyed.

Tests made in March were not nearly so effective as the iron sulfate. In fact, very little injury resulted from the fertilizers.

ACTION OF FERTILIZER SPRAYS.

The effect of the nitrate of soda, kainit and other similar salts seems to be to take water from the tissues of the plant until it wilts and later dries up and dies, though other action may take place. A poisoning effect or interference with the normal chemical action of the cells may result.

Some tests were made with cuttings of chickweed, plantain, tomato, potato, cowpea, lamb's quarters, etc., all except the cut end being immersed in strong solutions of sodium nitrate, kainit, potassium nitrate, sodium arsenite and iron sulfate, with others in water for a check. After two hours, when they were removed, those in sodium nitrate and kainit were badly wilted, and those in potassium nitrate wilted but not so much. In sodium arsenite and iron sulfate they were slightly wilted, but in the former had a cooked appearance. Those in water were perfectly fresh.

The plants were then washed and the cut end placed in water and when examined next day, those in kainit and sodium nitrate had recovered except in some cases their leaves were dead at the tips, apparently not being able to recover their turgidity entirely before being dried out in the air. Those from iron sulfate showed more injury, the dry spots having turned black.

Those from the arsenite were in many cases still wilted or showed that the leaf even when somewhat turgid was turning yellow.

EFFECT OF WASHING OFF SPRAYS

Plants of winter cress, ripple, plantain, sorrel and chickweed were potted in the greenhouse and after two weeks thoroughly sprayed with iron sulfate, 2 pounds to the gallon, nitrate of soda ¼ pound with kainit 1½ pounds per gallon, and sodium arsenite 1 gram per gallon. The weather was cloudy for two days after the spraying and no effect showed except some wilting until the sun came out, when the injured leaves dried up quickly. Some of the plants were washed in running water 1 minute after spraying, others were immersed in water for 15

	Sodium arsenite			Iron sulfate			Sodium nitrate and Kainit		
	washed in one minute	washed in three hours	not washed	washed in one minute	washed in three hours	not washed	washed in one minute	washed in three hours	not washed
Winter cress	lower leaves dead	lower leaves dead	nearly dead		lower leaves dead	nearly dead		not injured	dead
Ripple	a few lower leaves dead	nearly dead	nearly dead		a few lower leaves dead	lower leaves dead		not injured	lower leaves dead
Plantain	a few lower leaves dead	dead	nearly dead		not injured	lower leaves dead			
Sorrel				not injured	nearly dead	dead	not injured	not injured	not injured
Chickweed	dead	dead	dead	recovering	nearly dead	dead	not injured	not injured	almost dead

minutes three hours after treatment, and some were left without washing. The table on page 15 shows the results, as noted after three weeks.

OTHER SPRAYING EXPERIMENTS.

In March, 1909, a small plot of alfalfa was sprayed with iron sulfate 2 pounds per gallon of water and another with nitrate of soda ¼ pound and kainit 1½ pounds per gallon. The product of 5 square feet of each was examined, weighed and compared with adjoining unsprayed areas at the time of first cutting (May 24). Practically no weeds were present except couch grass in both sprayed and unsprayed, and the total yield of the sprayed plots was somewhat less in weight than the unsprayed.

Different strengths of iron sulfate, sodium nitrate and kainit were tried during the summer of 1909 for weed killing sprays along roadsides and while most weeds were killed or seriously checked, such treatment was not economically efficient as compared with mowing.

EXPERIMENTS IN KILLING TREES AND SHRUBS WITH CHEMICALS.

July 3, 1907, 6 ounces each of the following substances were applied around the roots of peach trees diseased with yellows in the effort to find something that could be used to quickly kill such trees or any others that it might be necessary to destroy: Chromic acid (½ ounce in water), kerosene, copper sulfate (1 ounce in water), carbon bisulfide, caustic soda (2 ounces in water), salt (saturated solution in water), sodium hyposulfite (2 ounces in water), potassium cyanide (½ ounce in water), commercial sulfuric acid, 2% corrosive sublimate, sodium nitrate (1½ ounces in water), iron sulfate (1½ ounces in water), gas tar, sulfurous acid. The earth 2 inches deep was raked away from the tree and replaced after the chemicals had been poured in.

In five days leaves on the trees treated with copper sulfate and carbon bisulfide showed marked injury. None of the others showed any effect of the treatment. The tree treated with carbon bisulfide died in a short time, while the copper sulfate tree recovered by the next spring.

In the winter of 1909-10 sodium arsenite, 4 to 8 ounces per gallon; salt, 2 pounds per gallon, 1 to 2 gallons per linear rod; and kerosene one-fourth to one gallon per rod, were tried by pouring around the roots of Japanese quince hedge without success in killing it, on account of sprouting from the roots some distance from the base of the stems.

In September, 1909, kerosene, sodium arsenite (½ ounce per quart), carbon bisulfide, and chromic acid (½ ounce per quart), were applied at the base of young ½ inch to 1 inch apple, peach, black locust and sumach trees; about ½ ounce per tree being given. When examined a few weeks later, it was found that the kerosene caused but little injury to peach and apple, even when the bark was broken at the base. Sodium arsenite had killed most of the leaves and probably the whole tree in both peach and apple. The same was true of the carbon bisulfide. No injury from the chromic acid was noted.

Another trial with 1 to 2 inch apple in which one of the large branches near the ground was cut and the liquids poured on, resulted similarly, showing marked injury from the sodium arsenite and carbon bisulfide, on the cut side especially, and none from kerosene and chromic acid. Very little injury was noted on the sumach or locust from any treatments.

Among a number of treatments made in 1908 to study the penetration of various substances into the wood of trees when applied through the cut end of branches, oxalic acid was found to penetrate and kill the wood and leaves quicker than any other substance tried.

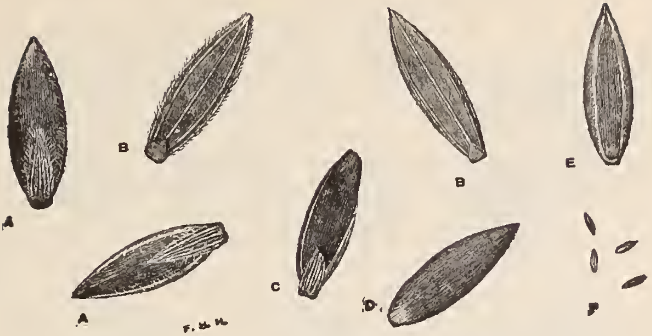
CLEAN SEED.

The question of pure seed is a very important one in weed control. Its agitation in recent years has already greatly improved the quality of seed on the market. There is scarcely any agricultural question of more vital importance than the question of good seed; none in which slighter differences can have greater influence on the result; none in which there is greater opportunity for fraud.

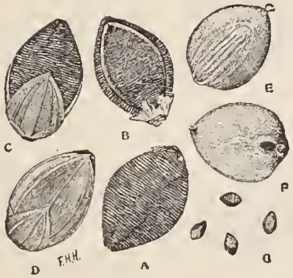
Nearly all our bad weeds have been introduced in seeds of various crops, especially in grass and clover seed. Weeds are being carried every year to new localities in this way. One must be constantly on the lookout, and no seed should be sown without a careful examination for weed seeds. The recognition of the different weed seeds is generally too technical a question for the average person, some special study of the different species being necessary or authentic samples at hand for comparison, but by careful examination of the common weed seeds with a good hand lens or a reading glass one can soon recognize them in a seed sample. It would be an excellent thing to keep at each rural center, school house, grange hall, etc., a set of all available weed seeds kept in small labeled vials, for the use of the neighborhood, and especially for the education of the children. Samples of seeds of all obtainable cultivated plants should be kept with them and arranged so that those which are most apt to be mistaken for one another are side by side.

Every farmer wants to be sure whether the seed he is planting is the variety or strain he wants, and whether it has sufficient vigor to make healthy plants, that is, whether it will germinate properly and whether it carries any infectious disease. He also wishes to know whether it is adulterated with weeds or other plants not desired.

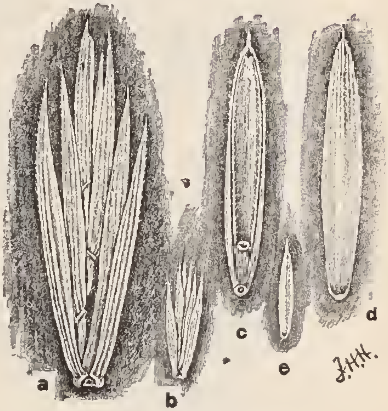
Some of these questions can only be determined by knowledge of the source of the seed, and he who can know the history of his seed or save it himself is fortunate in that respect. Others, as vitality and purity, can be determined in most cases by proper methods of examination or analysis. The United States Department of Agriculture and those in charge of similar work in many of the states, have provided means by which seed samples can be examined for purity and vitality by experts, and some states have laws with proper penalties to compel dealers to guarantee seeds to some extent, and to enforce seed inspection. There is now no such law in Maryland, and consequently nothing but the vigilance of the farmer and the working of public opinion to prevent unscrupulous dealers from selling seed of inferior quality to the unsuspecting. A limited quantity of seed samples have been examined by this Experiment Station or the Agricultural College each year, but there is no special fund which can be used for that purpose, but arrangement has been made whereby seed for analysis may be sent to the Botanical Department, Maryland Agricultural College, College Park, Maryland, where purity tests will be made for 25 cents per sample. One to two ounces of each kind should be sent and a duplicate sample with the same number or name retained by the sender. If desired a vitality test may also be made for 25 cents additional for each sample.



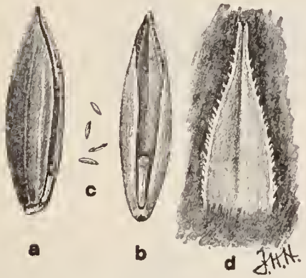
1.—Crab grass.



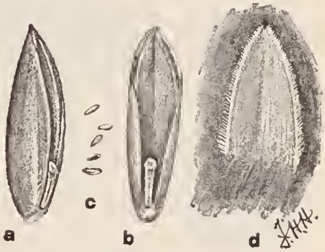
2.—Yellow foxtail.



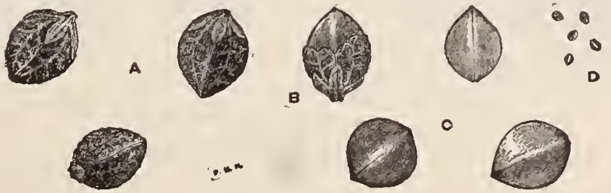
3.—Couch grass.



4.—Blue grass.

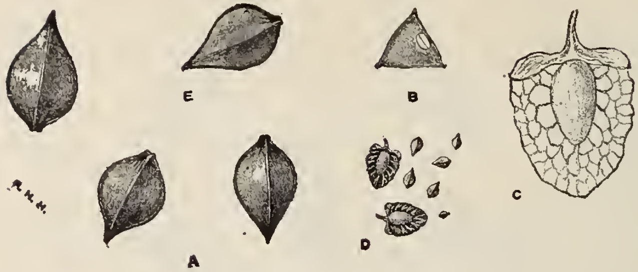


5.—Canada blue grass.

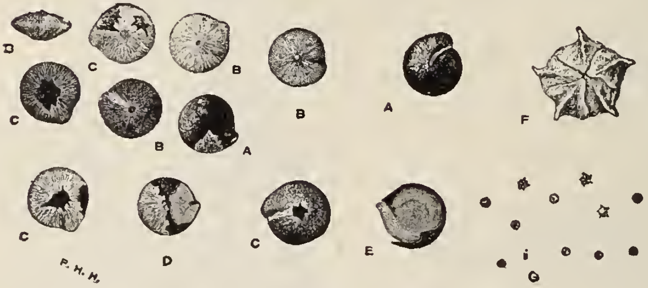


6.—Sorrel.

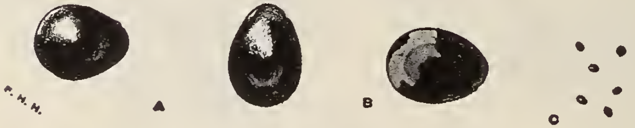
PLATE I.—Weed seeds (after Beal).



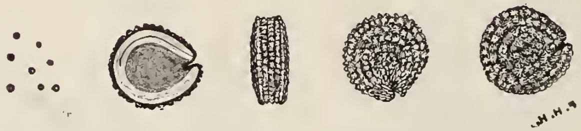
1.—Narrow dock.



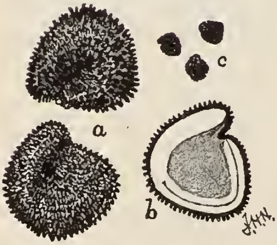
Lamb's quarters.



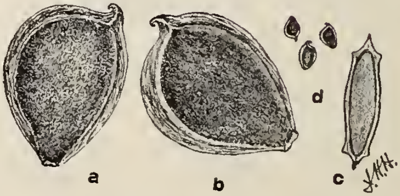
3.—Pigweed.



4.—Chickweed.

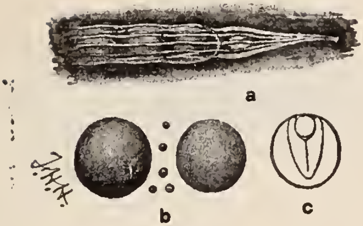


5.—Cockle.

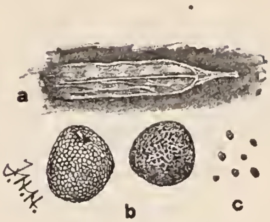


6.—Buttercup.

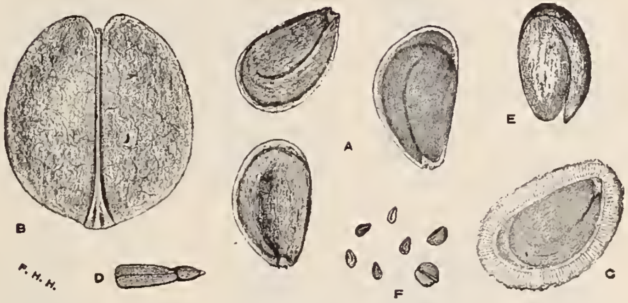
PLATE II.—Weed seeds (after Beal).



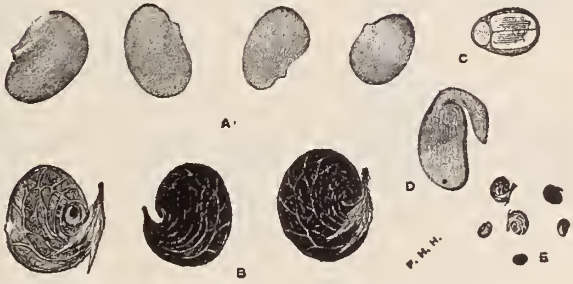
1.—Charlock.



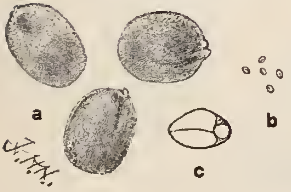
2.—Black mustard.



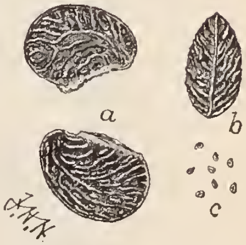
3.—Peppergrass.



4.—Black medick.

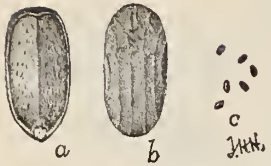


5.—Winter cress.

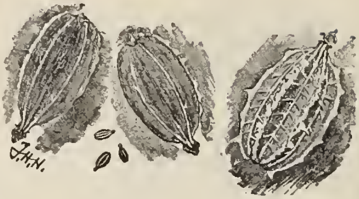


6.—Cinquefoil.

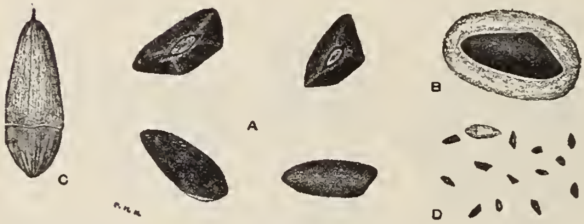
PLATE III.—Weed seeds (after Beal).



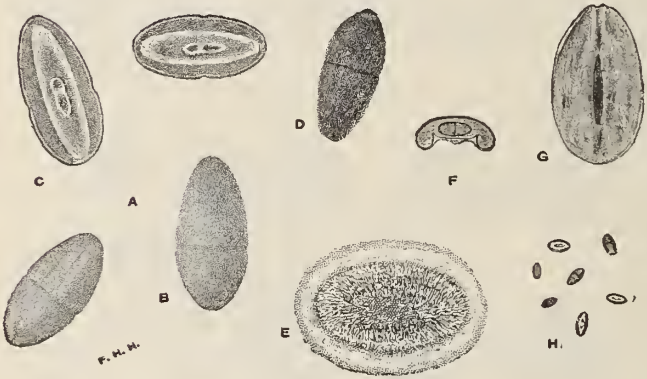
1.—Vervain.



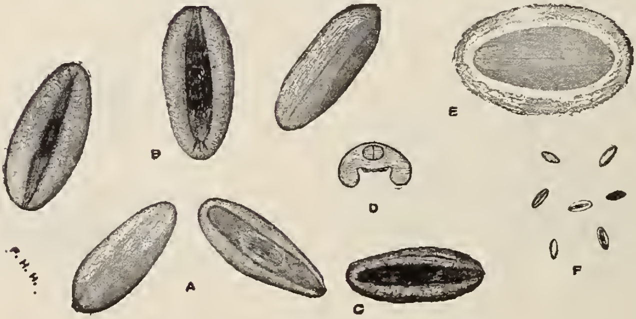
2.—Wild carrot.



3.—Plantain.

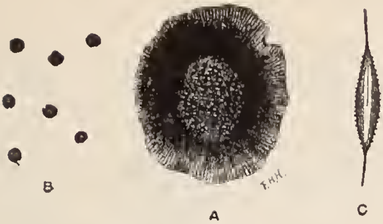


4.—Bracted plantain.

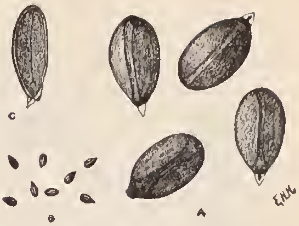


5.—Ripple.

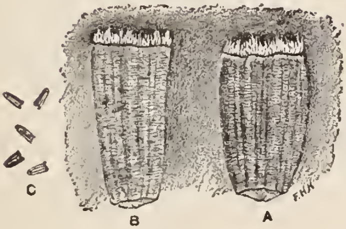
PLATE IV.—Weed seeds (after Beal).



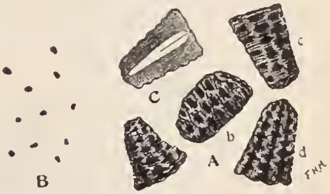
1. -Butter and eggs.



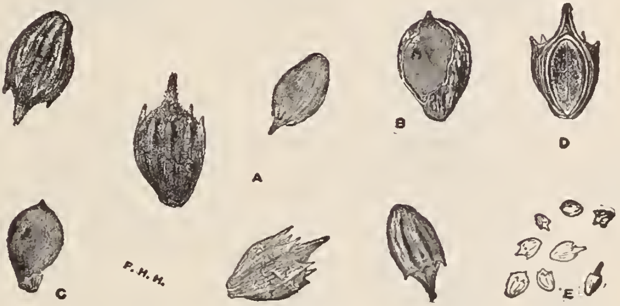
2.—Heal-all.



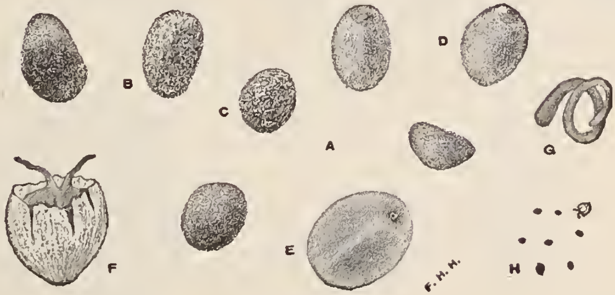
3.—Chicory.



4.—Moth mullein.

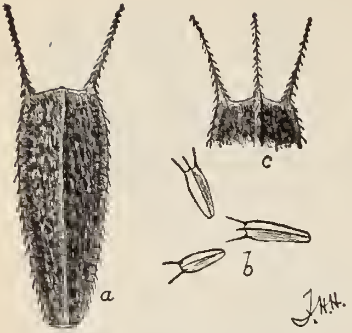


5.—Ragweed.

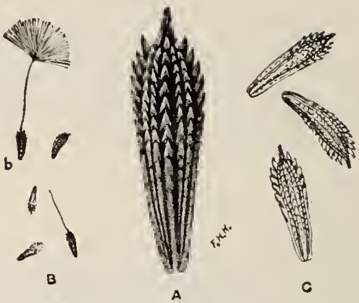


6.—Clover dodder.

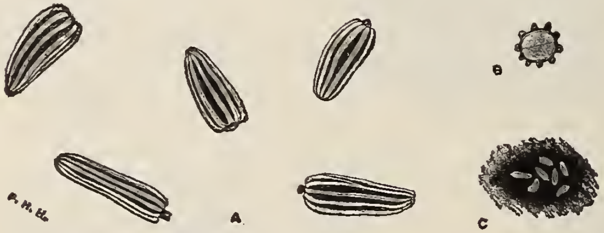
PLATE V.—Weed seeds (after Beal).



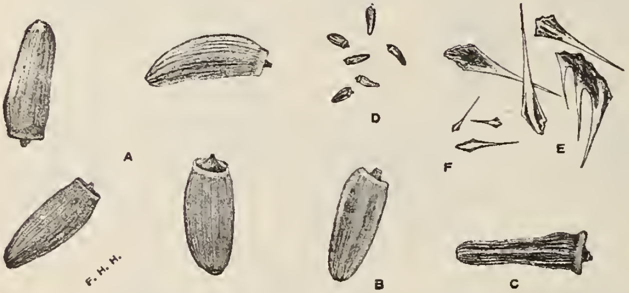
1.—Stick-tight.



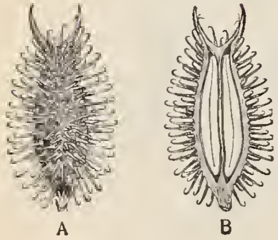
2.—Dandelion.



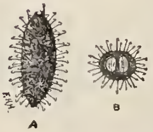
3.—Oxeye daisy.



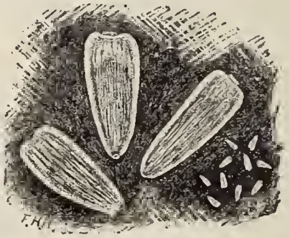
4.—Canada thistle.



5.—Cocklebur.



6.—Spiny cocklebur.



7.—Yarrow.

PLATE VI.—Weed seeds (after Beal).

SEED LAWS.

In looking forward to possible seed legislation for Maryland it may be said that the best plan is (1) to avoid an elaborate inspection system, (2) to require a seller's analysis and reimbursement by the dealer if the seed does not come up to sample, or publish the results of expert analyses of many samples from each seed dealer in the State. (3) the law must not interfere with trade in the best quality of seed, but restrict the sale of low grade seed and let the purchaser know just what he is buying.

Laws have been enacted in many States to secure the destruction of weeds or their control along highways and on farms. A model law of this kind is outlined in Bulletin 17, Division of Botany, U. S. Department of Agriculture.

PRINCIPAL WEEDS OF MARYLAND.

In order to intelligently fight weeds, it is necessary to distinguish the different kinds and know the peculiar habits and methods of life of each. So in a publication of this kind it is desirable to include some means of recognizing and naming the different kinds.

On any one farm hundreds of species of wild plants might be found, while a farm in one part of the State might support many kinds not found in another location. Manifestly only the more important ones could be fully treated in a bulletin of reasonable size and a comparatively small number are of real importance as weeds.

In the following pages the weeds are grouped according to their importance to agriculture, and under the numbered paragraphs devoted to each is included a very brief description of some of the characteristics that will enable one to distinguish each one from other plants that might occur, and also brief notes on control, giving the special methods if any to be used for each.

In addition to the important weeds treated more fully, others frequently found are at least mentioned by name, but scarcely any of the marsh or woodland plants are given as these nearly always disappear under cultivation. Most of the cultivated poisonous plants are included. For more complete works the reader is referred to Volume III, Maryland Weather Service, where 500 pages are devoted to the plant life of Maryland; or to Gray's New Manual of Botany, which is the most recent publication giving descriptions and names of all the higher plants of this region.

In distinguishing by name the various kinds of weeds one must be particularly careful on account of different names for the same weed being in use in different parts of the country. In the following pages the English name most commonly used has been given and to increase accuracy it is followed in parenthesis by the scientific name applied to that plant in Gray's New Manual of Botany. Where common names have been used alone throughout the bulletin, the proper genus may be found by reference to the index.

KEY TO MARYLAND WEEDS.

By carefully comparing any weed at hand with the following key or often by use of the index and illustrations alone, one may find the name of almost any common weed or other injurious plant, and most of those occasionally found in this State. The key is based on easily distinguished characteristics, and requires but little knowledge of botany. One should be able to distinguish compound leaves (as in the clover leaf with 3 leaflets and the locust with several leaflets to each leaf) from simple ones, and know the parts of the leaf (petiole, blade, and stipules). It would also be well to know the parts of the flower (sepals, petals, stamens, pistils) ; but foliage and general habit characters have been used when possible, as these are the most common and conspicuous features to the ordinary observer.

Most of the species considered could just as well be distinguished in the seedling stage or from seeds alone, and farmers' children should be taught to do so.

To use the key compare the plant to be named with paragraph 1. Then pass to the paragraph there indicated which fits the plant in hand. Proceed the same with this paragraph and so until the name is found. Thus, if one should have a plant of chickweed, and not knowing what it is, wishes to find out from the key, comparing it with paragraph 1 he is referred to 2 for plants with leaves and stem; 2 refers him to 27 for herbaceous plants; 27 leads him to 39 for all plants not having grass-like leaves. Under 39 he finds by examining the flowers that the plant does not belong to the mustard family, or composite family, and so goes to 40. As the plant does not have milky juice he is lead to 45; there he is referred to 47 for all unarmed plants. Under 47, finding that it is not a climbing plant he goes to 48, where for plants with opposite leaves he is lead to 50. Under 50 he is lead to 51 for plants with entire leaf margins. 51 refers him to the special paragraph on the pink family, 52, where, as the plant is low and spreading, he goes to 53. There he is referred to chickweed in number 97, where the weed named is further discussed.

Some plants that are not important as weeds are included in the key, but only mentioned by name if at all elsewhere. In most cases where one might be in doubt, under which division of the key to look for a plant, it has been provided for under both.

1. If the plant is a greenish water scum or forms a green coating without definite form to the naked eye it is probably one of the algae (see 199). If it is a mold, mildew, rust, smut, mushroom or other fungus, see 200-203, or consult our bulletins or other works on fungi and plant diseases.

If the plant has distinct stems and leaves see 2 (or for true mosses, 162). The grayish, yellowish, or greenish, moss-like growths on tree trunks, soil, stones, etc., are usually lichens.

2. See 3 for all plants (trees, shrubs and woody vines) with woody stems which remain alive over winter. For herbaceous plants, of which only the roots, or leaves and roots, or creeping stems live over winter, or the annuals, which live only one season, see 27.

3. See 4 for woody vines, and 9 for trees and shrubs.

4. For vines with thorns or prickles see 5. For vines without such, 6.

5. Leaves simple with 3 or more prominent nerves, see smilax; leaves simple not strongly nerved, see matrimony vine, 223.
If there are 3 or more leaflets to each leaf it is probably a species of Rubus (see blackberry, raspberry, wineberry, etc., 102, 198).

6. If the leaves are in pairs, see 7; if not in pairs, but alternate on the stem, see 8.

7. If climbing by bending of the leaf stalks, see clematis (209). If climbing by the twining stem, see honeysuckle (113, 227). If climbing by aerial rootlets, see trumpet creeper (153, 227).

8. Climbing by the twining stem, see bitter sweets (223, 227). Climbing by aerial rootlets, see poison ivy (215 and page 14).

9. For trees or shrubs with thorns or prickles on stem or leaf, see 10; without such, see 15.

10. Leaves evergreen, see 11; leaves deciduous, see 12.

11. Leaves needle-like, 2 or more together and over two inches long, see pine (196); leaves scale-like or pointed, less than ½ inch long, see cedar (227); leaves broad, sharp points around the edge, see holly (227).

12. Leaves compound, see 13; leaves with only one blade to each, see 14.

13. Leaves each with 3 to 5 pointed leaflets, see various species of Rubus (blackberry, dewberry, raspberry, wine berry, 102, 198); leaves with several oval leaflets along each side the main leaf-stalk, see locust (198, 213).

14. Juice somewhat milky, a sharp spine at the base of the leaf stalk, see Osage orange (197, 227); juice not milky, includes some spiny plums (198), hawthorn bushes, and matrimony vine (223).

15. Leaves in pairs (opposite on the stem), see 16; leaves alternate, see 18.

16. Leaves evergreen, see box (214), a shrub with small oval leaves; oleander, a house plant with long, narrow leaves (222); some species of privet (221), and evonymus (227), retain the leaves all winter. If the leaves are deciduous refer to 17.

17. This includes the horse chestnut or buckeye, a tree with palmately compound leaves (227); elder, a shrub with large, pithy twigs and compound leaves (193, 227); wahoo or burning bush, species of evonymus both wild and cultivated, with square, green stems and red fruit (227); and the cultivated shrubs, privet and forsythia, the former used for hedges and the latter for its early, yellow, bell shaped flowers (221).

18. Leaves compound, see 19; leaves simple, see 22.

19. Each leaf with 3 to 5 leaflets see 20; 7 or more leaflets on most of the leaves, see 21.

20. This includes the blackberries, raspberries, and other species of Rubus without spines (102, 198); the Scotch broom (196, 213); and poison ivy and poison oak (215).

21. Many small teeth on the margin of the leaflets, see sumach (198), or mountain ash (227).
Only a few teeth at base of leaflet and twigs very large, see ailanthus (198, 227).

Leaflets entire or toothed, and a wing along the stalk between the leaflets, see dwarf sumach (198).

If the leaf margins are entire, see locust (198, 213), poison sumach (215), or Kentucky coffee-tree (213).

22. Leaves evergreen, see laurel and rhododendron (219), and others in 11; leaves not evergreen see 23.

23. Juice slightly milky, see Osage orange, with smooth, entire leaves (197, 227), and paper mulberry, with rough, entire or lobed leaves (198); juice not milky, see 24.

24. Leaves toothed on the margin, see 25; leaves with entire margin, or with a few rounded lobes, see 26.

25. This includes silver poplar, with leaves white beneath (198), English elm (198), some willows, with long narrow leaves (198), cherry, plum and wild cherry (198, 212).

26. Includes sassafras, with large, entire or lobed leaves (118 227), stagger bush, a small woodland shrub (219), matrimony vine, a vine-like shrub about habitations (223), and persimmon (196).

27. For grasses or other plants with long, narrow, parallel-nerved leaves, see 28.

For broader, more or less netted-veined leaves, or leafless or very small leafed plants, see 39.

Other plants with somewhat grass-like leaves may be distinguished by the colored flowers, from those in 28 (see 39 for such).

28. For floating water plants see pondweed and eel grass (193).

For plants of very wet land, see 29.

For ordinary field plants, etc., see 30.

29. Plants with leaves over ½ inch broad and very long, see cat-tail (193), or day lily (193); plants with leaves over ½ inch broad but less than 3 inches long, see day flower (135); plants with leaves long and narrow, see nut grass (134, 193) and other sedges with three-cornered stems, and cut grasses with round stems and rough cutting edges to leaves (193); see also water willow (193) with opposite leaves.

30. Spreading by underground, scaly or wiry stems, see 31.

Spreading by bulbs or tubers, see 32.

Underground parts only a cluster of fibrous roots or some buds at base of stem, see 33.

31. Grasses with leaves over 10 inches long and flat or folded, see Johnson grass, with broad grass-like leaves (197); day lily, with folded, lily-like leaves (193), and couch grass with long, narrow leaves (133, Plate VII, 3).

Grasses with most of the leaves less than 5 inches long, see nimble Will (130, Plate VII, 2). Bermuda grass (131, Plate X, 7), Canada blue grass, with flat stems (196, Plate I, 5). One might look here for butter and eggs (151, 224, Plate V, 1), and some of the narrow-leafed golden-rods (114).

32. See nut grass, with triangular stems (134, 193), garlic, with cylindrical leaves and strong odor (92), and star of Bethlehem and grape hyacinth (136, 137), with flat leaves and cylindrical stems.

33. The true grasses have cylindrical stems, and the leaves have the sheath, or lower portion, wrapped around the stem for some distance above the joint, see 34 (Plates I, VII and X).

The sedges are grass-like but the stems are three-sided and the sheath forms a closed tube around them (134, 193), see also day flower (135, Plate X, 12).

For other plants here included, see 39.

34. The grasses can perhaps best be separated by the form of flower cluster (head, etc.), which they produce, and by the spikelets, that is, the little cluster of scales or chaff that encloses one or more flowers or seeds (See Plate I).

For grasses with cylindrical heads, such as timothy, see 35.

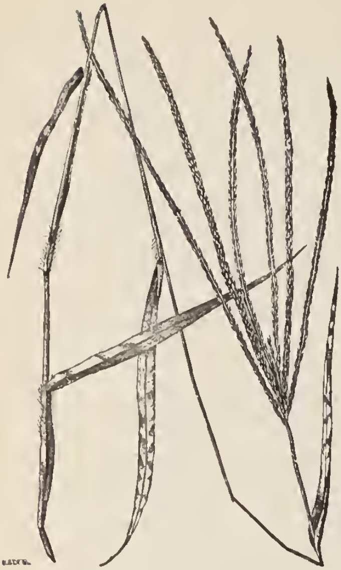
For those with slender spikes or heads, with the spikelets all on one side (Plate X, 5, 6, 7), see 36.

For somewhat two-sided, unbranched heads like wheat or rye, see 37.

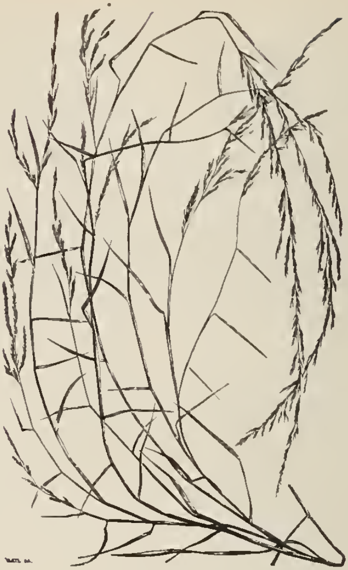
For variously branched heads, as oats and blue grass, see 38.

If the seed is enclosed in burs, see sandbur (129).

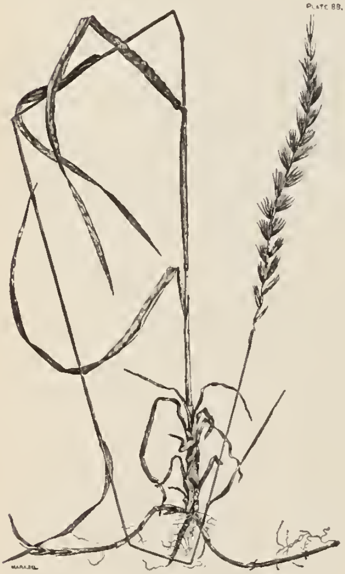
The rushes (196) can be distinguished by having small pods with numerous very small seeds in each.



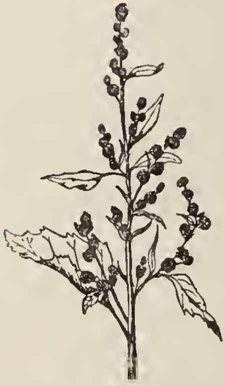
1.—Crab grass.



2.—Nimble Will.



3.—Couch grass.



4.—Lamb's quarters.

PLATE VII.—Grasses and lamb's quarters (after Selby).

35. This includes three or four species of foxtail with short bristles standing out beyond the round grains all over the close head (109) ; the canary grasses without bristles or hairs in the head; and sweet vernal grass (195) with slender spikelets loosely arranged in the head.

36. Includes the paspalums (163), with short rounded spikelets; the crab grasses (89), with pointed spikelets and the branches of the head less than one sixteenth of an inch wide; and yard grass (167) with branches about one eighth inch wide (see also Bermuda grass, 131).

37. Includes rye (197), wild barley (194), and wild rye, etc., with spikelets close together in the head; and darnel and rye grasses (195) with spikelets separated on the stem of the head; see also couch grass (133, Plate I, 3; Plate VII, 3), cheat (132) and broom sedge (166).

38. Of these, tall red-top is a large, late flowering grass with a dark, waxy secretion on the upper part of the stem (165) ; the panic grasses have small, roundish spikelets like seperate seeds on the ends of the many small branches (164) ; the head of broom sedge is covered with fine feathery hairs (166) ; wild oat grass and poverty grass have spreading awns on the spikelets (196); the cheats have long, thick spikelets of several scales each (132) ; annual blue grass and stink grass (194) are low grasses with small, flat spikelets of several scales each, the latter with a strong scent when rubbed; barnyard grass (194) has rough, hairy spikelets of one large seed each in a rather dense, branching panicle.

39. It will be best here to first separate two of the large families of plants that contain many weeds not easily distinguished by the leaves, by using the easily recognized family characters found chiefly in the flowers; but most of these will be included also in 40 where they may be found on their foliage characters; if not thus found refer to 77, 78 and 79.

These are (I) the mustard family (See Plates III and IX) with the pungent flavor of mustard, cabbage, turnip, etc., the small flowers having 4 petals, 6 stamens, 2 shorter than the other 4, and a single pod usually with several seeds in two rows (For those with yellow flowers, see 78; for those with flowers white, purple, etc., see 77) ; (II) the composite family (79, also some with milky juice in 44) in which a number of small, strap shaped flowers, as in the dandelion (Plate X, 8 and Plate XII, 4), or a row of strap shaped flowers surrounding a disk made of smaller flowers of a different kind, as in the daisy (See Plate X, 9), are collected into a head which looks to the less careful observer like a single flower.

For plants not in these families see 40.

40. For plants with milky juice (white or yellow), see 41.

For plants with watery or slightly colored juice, see 45.

41. For plants with yellow juice see members of the poppy family: fumitory (196, 227), poppy (184, 227), celandine (196, 227), seapoppy (196).

For vines with whitish juice see the morning glories (107, 227, Plate X, 1, 2) bindweeds (147, 227, Plate X, 3; XI, 1) and angle pod.

For other plants with white juice, see 42 for those with all leaves opposite, and 43 for those with alternate leaves on the main stem.

42. For plants with leaves over two inches long see caper spurge, with 4 rows of long, narrow leaves and three-seeded pod (214) ; Indian hemp, a branched plant with smooth leaves and long, slender pods in pairs (146, 227) ; common milkweed with broad leaves, downy on the lower side (115, 227), and swamp milkweed with narrower leaves (115, 227) ; for plants with smaller leaves and three-seeded pods, see the lesser spurges (194, 214).

43. For plants with small teeth or notches in the edge of the leaves, see 44. For plants with entire leaf margin, see snow-on-the-mountain and other spurges (194, 214), and rattlesnake-weed and other hawkweeds (196), see also lobelia (225).

Some plants like the skeleton weed (Plate X, 8, 156) have only a few very small, entire leaves on the stems but, at least early in the season, produce a bunch of notched leaves at the ground.

44. For small, blue flowered plants with roundish leaves clasping the stem, see Venus-looking-glass (194) and some lobelias with small, bluish flowers (225).

For blue or white flowers with strap-shaped petals, see chicory (Plate XII, 4, 155) and some wild lettuces (227).

For low, stemless plants with yellow flower heads, see dandelion (Plate VI, 2) with flower heads 1 inch across (121), and dwarf dandelion, flower heads ½ inch broad (194).

For taller, yellow flower heads, see skeleton weed (156, Plate X, 8), with much branched, almost leafless stems; ox tongue (192), with rough hairy leaves, and stems; sow thistle (183, Plate XII, 3), with almost hairless leaves and 50 or more very small flowers in each little head; and wild lettuce (157, 227) with smooth leaves and not over 30 flowers in each head.

45. For plants with green color and spines or prickles, see 46.

For green plants, not armed or only with sharp hairs, see 47, and stinging nettle (196, 227).

For plants without green color, see dodder (149, Plate V, 6), a slender, yellow vine, and broom rape (189), an upright plant attached to clover roots, etc.; see also horsetail, a stiff jointed plant, usually without branches (227).

46. For plants with thick, flat, jointed stems and no leaves, see prickly pear: for plants with spines only on the pods or other seed producing parts, see Jimson weed (112, 223, Plate XIII, 3), teasel (172), cocklebur (119, Plate VI, 5, 6), Spanish needle (101, Plate VI, 1), sandbur (129), motherwort (196) and burdock (108, 227); for plants with spines on the stem at base of leaves, see spiny cocklebur (158, Plate VI, 6), with notched leaves, and spiny pigweed (139) with entire leaves; for plants with spines on both leaves and stem see horse nettle (110, 223, Plate IX, 4), and buffalo-bur; for spines on leaves but not stems, see thistles (111, 227, Plate XII, 1, 2). The sow thistle (183, Plate XII, 3), prickly lettuce (157, 227) and teasel (172) have some weak prickles on the leaves and stem.

47. For non-climbing plants refer to 48.

For plants climbing by tendrils on the ends of compound leaves, see vetches or tare (188).

For plants climbing by twining stems, etc., see the bindweeds, and morning glories (107, 147, 227, Plate X, 1-4; XI, 1), with alternate, simple, arrow-shaped or heart-shaped leaves; the wild beans, with alternate leaves of three leaflets each (194); aconite (209), with many-lobed, alternate leaves; bittersweet (223), with alternate, simple leaves with a few deep lobes at the base; and climbing hemp-weed (193), with opposite heart-shaped leaves.

48. The following division into whorled, opposite and alternate leaves, applies especially to the normal leaves at the middle of the stem and not to upper or lower or other less perfect ones; and does not include the leaves from the buds or very short branches immediately above the main leaf or leaf pair; also, large stipules should not be confused with leaves.

For weeds with three or more leaves at each joint of the stem (whorled), see 49.

For those with two leaves at each joint (opposite), see 50.

For those with only one leaf at each joint (alternate) or only a cluster of leaves at the base of the plant or leafless plants, see 61. Some young plants with opposite or whorled leaves might be looked for here by mistake.

49. For tall plants of wet places, see Culver's root (224) with long spikes of white flowers, and Joe-Pye weed with flat-topped clusters of purple flowers (193).

For small plants, prostrate on the ground, see carpet weed (194).

For small plants, erect at least at the tip, see waxweed (196), with clammy stems; bedstraw and field madder (196), with rough, square stems; and spurry (194), with smooth round stems.

50. For plants with entire margined leaves, see 51.

For plants with toothed or lobed leaves, see 55.

51. For tall plants with rough, almost prickly stems, see teasel (172).

For plants with long, narrow leaves, growing along the edges of streams, see water willow (193).

For low, smooth, succulent plants with small, yellow flowers, see pursley (105).

For narrow leafed plants with purple, funnel-form flowers, see gerardia (196, 224).

For plants with translucent or black dots on the leaves or with fragrant odor, see St. John's-worts with 5 petals and St. Peter's-wort with 4 petals (196, 116, 217, one almost leafless), moneywort (152), pimpernel (220), mountain mint (196), and thyme.

For clammy hairy plants, see blue curls (194) and waxweed (196).

For low plants with small, white or blue flowers, see bluet (196), polypremum, button weed (154) and speedwells (152, 194); the latter have small, flattened, heart-shaped pods.

For the chickweeds and other members of the pink family included here, see 52.

52. For plants low or spreading, rarely over a foot high, see 53.

For erect plants, usually over a foot high, see 54.

53. For plants with short pods and leaves less than ⅛ of an inch wide and several times longer than wide, see lesser starwort (194), pearlwort (194), and knawel (194); for plants with broader, oblong leaves and cylindrical pods see mouse-ear chickweeds (171); for plants with broad, short or heart-shaped leaves, see chickweed (97, Plate XI, 2; II, 4) and sandwort (194).

54. For plants with densely white hairy leaves and red flowers, see cockle (140, 208, Plate II, 5); a smaller, less hairy plant with dense clusters of pink or red flowers and slender leaves is the Deptford pink (196); for viscid hairy plants, see night flowering catchfly (195), and white campion (195); for plants with hairs few or none, see sleepy catchfly, with upper joints waxy (194), bladder campion with rounded inflated calyx (195), bouncing Bet, with cylindrical inflated calyx (170), and cow herb with five-sided inflated calyx (195).

55. For leaves deeply lobed or cut halfway to the midrib, see 56.

For those with only small teeth on the margain or with shallow lobes, see 57.

56. For roundish leaves with several lobes, see cranesbill (194); for three lobed leaves, see motherwort (196), great ragweed (126), and cocklebur (119, Plate VI, 5, 6); for leaves with many small, narrow divisions or even compound, see Spanish needle (101, Plate VI, 1), ragweed (90, Plate V, 5) and lousewort (224).

57. For plants usually over 12 inches high, see 58. ,

For low plants with large, purple flowers, and strongly three-nerved leaves, see meadow beauty (196).

For other low plants, see the speedwells (152, 194), low erect or creeping plants with small, white or blue flowers and flat, heart-shaped pods, the leaves usually ½ to 1 inch long; eclipta (193), a plant of wet land with pointed leaves and inconspicuous composite flowers; and the following ones of the mint family.

Ground ivy (175, 227), with roundish leaves on creeping stems; dead nettle (176), with roundish leaves on partly erect stems; heal-all (196, Plate V, 2), with clusters of broad oblong leaves on very short stems; pennyroyal and thyme (196) with narrow, oblong, few toothed leaves on erect stems; see also bugle weed in 58.

58. For plants with the leaves united around the stem, see thoroughwort (193). For plants with small heads of composite flowers in flat-topped clusters, see other species of eupatorium (196). For those with small heads scattered on long stalks, and leaves not twice as long as broad, see galinsoga (159). For those with large, yellow flowered, composite heads see crownbeard, artichoke and other sunflowers (196).

For other plants with leaves not twice as long as broad see 59.

For those over twice as long as broad, see 60.

59. For plants with large, heart-shaped leaves, and bur-fruit, see cocklebur (119, Plate VI, 5, 6); for finely woolly leaves with rounded teeth, see horehound (196); for sharp-toothed, heart-shaped, woolly leaves, see catnip (120); see also basil thyme (196) with very small leaves and fragrant odor, wild marjoram and calamint.

60. For plants with mint-like or fragrant odor, see horse mint, wild bergamot (196), and mountain mint (196), all with more or less hairy or whitish leaves; and spearmint and peppermint (193), with smooth leaves. For other plants, see the vervains, with rough hairy leaves and stems, and flowers very small in slender spikes (196); figwort with hairless, square stems and open clusters of flowers (196, 224); monkey flower (193) and yellow rattle with single flowers above each leaf, and hedge nettle (196), and bugle weed (193), plants of the mint family but without aromatic odor.

61. For plants with a thin membranous sheath around the stem just above each leaf see 62.

For others see 63.

62. For broad leaves over 6 inches long, see the docks (106, 227, Plate II, 1); for triangular leaves see buckwheat (197, 227); for smooth stemmed plants with leaves two-lobed at the base, see sorrel (94, 227, Plate I, 6); for two-lobed or arrow-shaped leaves, with rough stems, see tear thumb (193); for tall plants with leaves over one inch broad, see Japanese knotweed (198, 227) and prince's feather (197); for low plants with small, narrow, blue green leaves, see yard weeds (196); for taller plants with larger, pointed leaves, and spikes of small pink or white flowers, see smartweeds (91, 193, 227).

63. For plants with leaves, none or inconspicuous, see horsetail (227) and asparagus (196, 227).

For plants with compound leaves, that is, divided to the midrib into three to many parts or nearly so, see 64.

For plants with simple leaves, but cut or lobed halfway to the midrib or more, see 74.

For simple leaves with margin variously shallow toothed or indented, see 81.

For simple leaves with entire margins, see 82.

64. If there are only three leaflets to each leaf, see 66.

If each leaf has more than 3 leaflets and the leaflets are broader than their little stalks, see 68 if the leaf divisions have entire margins, and 69 if the margins have many very minute teeth, 70 if the margins have relatively fewer and larger teeth or lobes, and 65 if the leaves are divided into very many fine, narrow, entire divisions, little, if any, wider than the stalks by which they are attached to the main leaf.

65. This includes larkspur, with blue or white, spurred flowers (209); corydalis (194), with small, yellow, spurred flowers; fennel (196, 218), with minute flowers in umbels; wild chamomile, dog fennel (160, 227), and yarrow (179, 227, Plate VI, 7) with composite flowers, the first two daisy-like. Similar to the last but with some teeth on the small divisions and they very slightly wider than the small stalks of the leaflets are tansy (196, 227), with yellow composite flowers; corn chamomile (180), with daisy-like flowers; Spanish needles, with long, barbed seeds (101, Plate VI, 1); ragweed with slender spikes of small, greenish flowers (90, Plate V, 5); poison hemlock with umbels of small, white flowers (218); wild carrot, differing from the last in its rough hairy leaves and stems (93, Plate IV, 2); and storksbill, a low, pink or purple flowered plant (194).

66. If the plant has only one or two leaves and a bulb-like root, see Indian turnip (204); if several leaves with heart-shaped leaflets and yellow or purple, bell-shaped flowers, see oxalis or wood sorrel (196, 227); if the flowers have only 4 petals, see clammy weed (196), or some of the mustard family (77). The others, with pea-like or clover-like flowers and pods are members of the legume family (67, Plate VIII).

67. For plants densely hairy, especially in the flower head, see woolly clover (144, Plate VIII, 39); for yellow flowered plants with inflated pod, see wild indigo (196, Plate VIII); for plants with leaves and jointed pods adhesive by minute, hooked hairs, see the beggar ticks (123, Plate VIII, 11, 13-21); for trailing, bean-like vines, see wild bean (194, Plate VIII, 32, 35).
For other plants, see Japan clover (Plate VIII, 25) or other bush clovers (196, Plate VIII, 12, 22-27) or other legumes in 69.

68. For leaves with 7 to 10 leaflets, all attached at the same point, see lupine (196, Plate VIII, 36); for plants with 7-25 leaflets arranged on each side the midrib, see partridge pea (194) and wild senna (196, Plate VIII, 34), with yellow flowers, crown vetch (196), with roundish heads of vetch-like flowers, and goats rue (Plate VIII, 7, 8), a hairy legume of dry woods; see also cress and other mustards (77, 78, Plate III and IX) in which the terminal leaflet is much larger than the others.

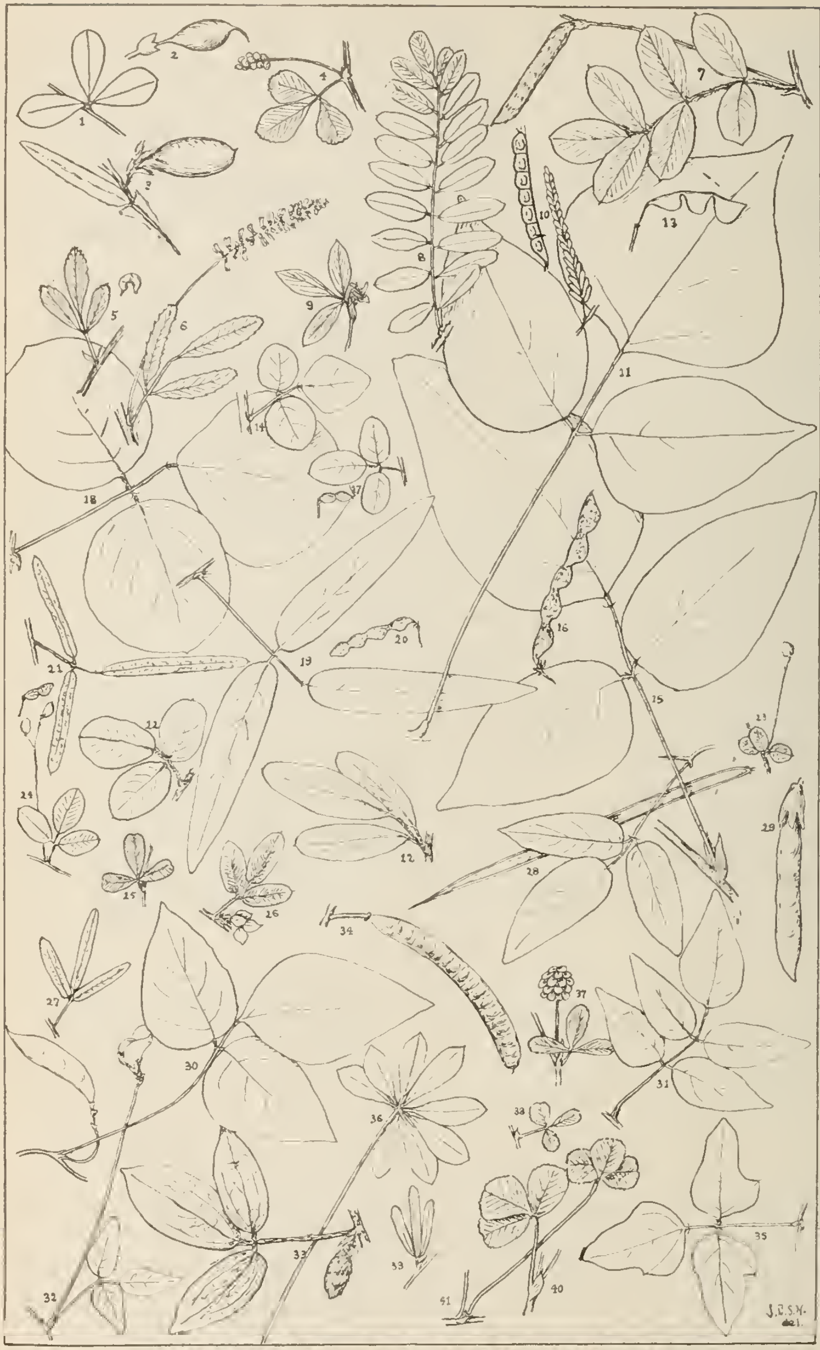


PLATE VIII.—Leaves and pods of Maryland legumes.

69. For fern-like plants, see flowering fern (193), with many leaflets to each leaf; for leaves with 5 to 7 leaflets each, see spider flower (196); for leaves with 3 leaflets each, see sweet clover with yellow or white flowers in slender spikes (173, Plate VIII, 6), and black medick (169, Plate VIII, 4), hop clover 196 (Plate VIII, 38) and yellow clover 196 (Plate VIII, 37), all with small yellow flowers in dense heads.

70. If the main divisions of the leaf are again divided, see 71.

If there is only a row of undivided, toothed leaflets on each side the midrib, see sensitive fern (193), cinnamon fern (193); also water cress, with white flowers (103), yellow cress (193), winter cress (103, Plate III, 5; IX, 1), and marsh cress, all with yellow flowers; radish, with purple flowers; and wild radish (187), with purple veined, yellow flowers. All, except the ferns, have 4-petaled flowers and the terminal leaflet of each leaf larger than the others. See also agrimony, with smaller leaflets between the larger and 5-petaled yellow flowers (196); parsnip, with yellow flowers in umbels; burnet 195), with greenish flowers in heads; and feverfew (196) and Spanish needles (101, Plate VI, 1) with composite flowers.

71. For ferns with many divisions to the leaf, see brake (196) and cinnamon fern (193).

For plants with many, broad, 3 to 7 toothed leaflets to each leaf, see meadow rue.

For leaves with few divisions radiating from the end of the main leafstalk, see 72.

For others with more feather-like arrangement of the leaf divisions or those further divided, see 73.

72. This includes the buttercups, with 3-12, few toothed divisions to the leaves (141, 209, Plate II, 6); the cinquefoils, with 3-5, about 10-toothed leaflets (124, Plate III, 6); the Indian strawberry, similar, but with red berries (195); all with yellow flowers; Indian physic, with 3-5 leaflets with many sharp teeth and white flowers (227); flower-of-an-hour, with buttercup-like leaves and large creamy flowers with a dark eye (194).

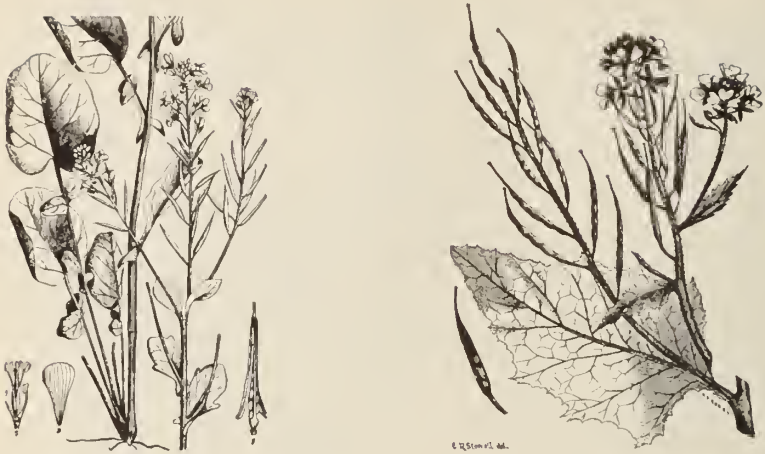
73. Includes angelica (196), with leaflets over half an inch broad, root not tuberous; poison hemlock (218), with leaflets less than ½ inch broad, root not tuberous; and water hemlock (218, Plate XIII, 2), with tuberous roots; all three with small, white flowers in umbels; also ragweed (90, Plate V, 5), with small, greenish flowers in spikes; Spanish needles with 2-4-barbed seeds (101, Plate VI, 1), and feverfew with small, daisy-like flowers (196).

74. For plants with only two, round, 5-9 lobed leaves, 4-12 inches broad, see may apple (210); for tall plants with many, large, 5-9 pointed leaves, see castor bean (214); for tall plants with large, 3-lobed leaves, see great ragweed (126); for large plants, with large, deeply several toothed leaves, long, funnel-shaped flowers and spiny pods, see Jimson weeds (112, 223, Plate XIII, 3).

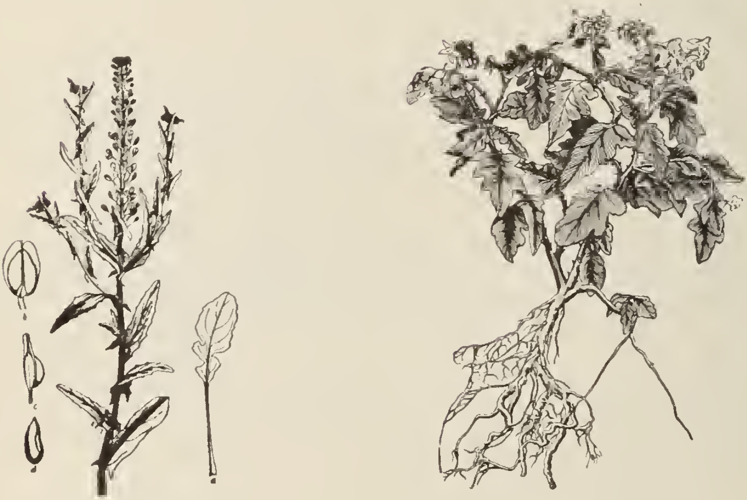
For other plants with the leaf lobes arranged along the midrib, see 76.

For those with more rounded form, see 75.

75. This includes primroses, large flowered house plants (220); wild geraniums or cranesbill, with small pink or red flowers (194); flower-of-an-hour, with large creamy flowers with a dark eye (194); a small, yellow flowered crowfoot (196, 209); and the blue or white flowered larkspur (209).


E R Stowell del.

1.—Winter cress. 2.—Charlock.



3.—Field peppergrass. 4.—Horse nettle.

PLATE IX.—Weeds of Mustard and Potato Families (after Selby).

76. For plants with the terminal lobe of the leaf much larger than the others and flowers with 4 petals and 6 stamens, see mustard family (77 for plants with flowers white, purple, etc., and 78 for those with yellow flowers).

For plants with composite flowers, see 79 or ragweed (90, Plate V, 5).

The others under 76 are sensitive fern (193); evening primrose (174), with 4-petaled flowers with 8 stamens; and lousewort (224) with curved, tubular flowers,

77. All the following have white flowers except radish, wild radish and rocket:

For plants with long, finely toothed leaves, see horse radish; for plants with purple flowers and jointed, fleshy pods see radish—the wild radish has yellow flowers with purple veins (187); for tall plants with white, pink or purple flowers, long, slender pods and shallow toothed leaves, see rocket; for plants with short, flat pods about ⅛ inch wide, see peppergrasses (142, 194, Plate III, 3; IX, 3); for short, flat pods over ½ inch broad, see penny cress; for somewhat triangular pods, see shepherd's purse (117); for very small plants, with flat pods, 2 to 3 times as long as broad, see whitlow grass (194); for water plants, with slightly longer pods, see water cress (103); for plants with slender pods, see garlic mustard, a tall plant with broad, toothed leaves; and mouse-ear cress, a low, almost entire leafed plant (194).

78. For plants with globose pods, see ball mustard (194); for pear shaped pods, see false flax (194); for flat or cylindrical pods, 2 or 3 times as long as broad, see some of the cresses; for plants with longer pods, see hare's ear mustard, with hairless, entire leaves (194), yellow cress, with creeping stems and pods ½ inch long (193), marsh cress, with even shorter pods and erect stems, both the latter usually in wet places; for other and longer podded plants, see black mustard (143, Plate III, 2), and hedge mustard, (flowers ⅛ inch long) both with the pods erect and pressed close to the stem,—one of the winter cresses (103) is similar; for plants with pods standing away from the stem or widely spreading, see tumbling mustard (186, Plate X, 11), with very long, slender pods and much divided leaves, and white mustard (143), with thick, bristly pods with a stout, flat beak; if the leaf base is heart-shaped or clasping around the stem, see cabbage, rape, kale, ruta baga or turnip; charlock is similar to the white mustard but less hairy and with smooth pods (143, Plate III, 1; IX, 2), curled mustard and Indian mustard have more slender pods and hairless, not clasping leaves; beside these are two winter cresses (103, Plate III, 5; IX, 1) with large round terminal leaflets and 2 to 16 smaller lateral leaflets.

79. For plants with small or much divided leaves see 80.

For plants with leaves over 3 inches across and more or less finely woolly beneath, see burdock (108, 227), with bur-like, purple flowered heads, and elecampane (196), with large, yellow flower heads.

For other plants with leaves more or less covered with fine wool, see corn flower (191), with blue flowers; groundsel, with deeply lobed leaves and yellow flowers (196); golden aster, with almost entire margined leaves and yellow flowers (196); and the everlastings, with small, greenish or white, at least never yellow flowers (196).

For other plants with large (one and one-half inch or more broad), almost entire leaves, see artichoke with yellow flowers (196) and other sunflowers, and elephant's-foot, with chiefly basal leaves and purple flowers (196).

80. For plants with much divided leaves, see corn chamomile, a low, white flowered, daisy-like plant (180); ox eye daisy (96, Plate VI, 3), over a foot high, with few-lobed or toothed leaves and larger flowers; and feverfew (196), a tall, branched plant with much divided leaves. For those with leaves only toothed or entire on the margin, see horseweed with greenish heads about ⅛ inch thick and many long, narrow leaves (127, Plate X, 10); fireweed with larger, cylindrical greenish, or white rayless heads and broader, toothed leaves (182); both strong scented. For tall, purple flowered plants with long, narrow leaves, see ironweed (125). For tall plants with small, white, daisy-like flowers, see whitetop (99, Plate X, 9), and asters (181). For plants with yellow-flowered heads, less than ½ inch across, see golden rods (114, 227). For larger yellow heads, see gum plant (195), with whitish gum outside the head; heterotheca (196), a sand plant, with leaves broadest below the middle; sneezeweed (226), with leaves broadest at the middle and rays broadest at the tip; black eyed Susan (128), with large heads with yellow rays and dark brown or black conical disk; see also some sunflowers (196).

81. For plants with composite flowers see 79.

For plants of the mustard family (4 petals, 6 stamens), see 76.

For plants with minute, greenish flowers, each producing a single seed no larger than a pin head, see wormseed, Mexican tea and Jerusalem oak (168), with aromatic odor; and lamb's quarters and other goosefoots (100, Plate II, 2; VII, 4), with somewhat triangular, few-toothed leaves.

For plants with very minute flowers and 3-seeded pods, see three-seeded Mercury (194).

For plants with thick, fleshy leaves, see live-for-ever (196).

For plants with large, densely woolly leaves, see mullein (178, 224).

For tall plants with large, velvety, heart-shaped leaves, see velvet leaf (122, 227).

For plants with prostrate stems and roundish leaves, see mallow (145).

For house plants with roundish basal leaves, see primrose (220).

For low, stemless plants with several prominent veins in the large, broad leaves, see plantain (95, 196, Plate IV, 3, 4, 5).

For stemless plants with heart-shaped leaves, and early, blue flowers, see violets (196, 227).

For other low, creeping, or erect plants with leaves less than an inch long and very small flowers, see speedwells (152, 194).

For plants with yellow flowers with 4 petals and 8 stamens, see evening primroses (174).

For similar tall plants with small, pink or white flowers, see gaura (196).

For plants with small, black berries, see black night-shade (194, 223).

For plants bearing large berries inclosed in an inflated husk, see ground cherry (177, 223).

For tall, branched plants with large, funnel-shaped flowers and spiny pods, see Jimson weed (112, 223, Plate XIII, 3).

For plants with small, greenish flowers, broad heart-shaped leaves and bur fruit, see cocklebur (119, Plate VI, 5, 6).

For small, yellow, 5-angled flower, see sida (196).

For smooth, succulent, yellow or orange flowered plants of wet land woods, see touch-me-not (193, 227).

For yellow or white, wheel-shaped flowers on a long unbranched stem, see moth mullein (178, 224, Plate V, 4).

For large, purple or white, tubular, garden flowers in spikes, see fox glove (224).

82. For plants with composite flowers, see 79.

For plants of the mustard family (4 petals, 6 stamens) see 76.

For plants with leaves not over one sixteenth inch wide, see asparagus (196, 227).

For plants with many slender leaves, ⅛ to ¼ inch wide, see kochia (197), with small, greenish flowers; gromwell (194), with small, white flowers and stiff, white hairs on the foliage; bracted plantain (190, Plate IV, 4), with spikes of small, inconspicuous flowers; butter and eggs (151, 224, Plate V, 1), with large spikes of yellow and orange, spurred flowers; pin weed (196), a low, much branched plant of dry land with many minute leaves; and toad flax, with blue flowers (196); see also true flax with blue or yellow flowers; pursley (105) has small, smooth, fleshy leaves.

For broader leaves see 83.

83. For plants with several prominent veins nearly or quite the whole length of the leaf, see the plantains (95, 196, Plate IV, 3, 4), with spikes of minute flowers; ripple (104, Plate IV, 5), with minute flowers in long stalked, cylindrical heads; lily-of-the-valley (206), with fragrant, white flowers (cultivated); and hellebore, a large leafed, tall, marsh plant (205).

For leaves with only one main vein and lateral branches, see 84.

84. For plants with leaves over 6 inches long and small, greenish, 3-sided flowers, see the docks (106, 227, Plate I, 6; II, 1).

For leaves over 4 inches broad or arrow-shaped, see elephant ear, skunk cabbage and other aroids (204).

For plants with smaller leaves and minute, greenish flowers in dense clusters with pointed scales, see the pigweeds (98, Plate II, 3) and tumble weed.

For creeping evergreens, see trailing arbutus (219).

For other low or creeping plants, see the speedwells (194, 152), with flat, heart-shaped pods; elatine, with triangular leaves (196); rattle-box, with an arrow-shaped wing on the stem below each leaf (213, Plate VIII, 3).

For plants with mature stems over 12 inches high, see 85.

85. For plants with hairy, velvety or clammy leaves, see 86.

For tall, smooth leaved plants with thick stems and producing small berries, see poke (207).

For low, smooth leafed plants with small, black berries, see black nightshade (194, 223).

For similar plants with berries enclosed in an inflated husk, see ground cherry (177, 223).

86. For plants with very large, clammy, strong scented leaves, see tobacco (223). For smaller, clammy leafed, garden flowers, see petunia, nicotiana (223), and some ground cherries (177, 223). For plants with large, velvety, heart-shaped leaves, see velvet leaf (122, 227). For plants with variously hairy leaves, see 87.

87. For rough, bristly plants with blue flowers and slender leaves, see blueweed (150, 227). For large, rough, broad leaves in a basal clump and tubular, purple flowers, see comfrey (196); for plants with large, silky or rough hairy leaves and small, white, blue or red flowers producing burs, see hound's tongue, beggar's lice, etc. (196); for narrow, hairy leaves, and flat topped clusters of yellow or orange flowers, see butterfly weed (227); for plants with 4-petaled, magenta flowers, see willow herb (196), or for those with 4-petaled, yellow flowers, see evening primrose (174).

FIFTEEN WORST WEEDS.

A number of farmers gathered at the Agricultural College at different times in recent years were asked to make up a list of the 10 worst weeds of their locality. This with lists made by some of the Experiment Station staff forms the basis of the following selection of the fifteen worst weeds of Maryland. They no doubt represent the 15 bad weeds of most general distribution, though others which occur locally may do more damage where they are found. These are arranged with the weed first which was included in the largest number of lists, and on.

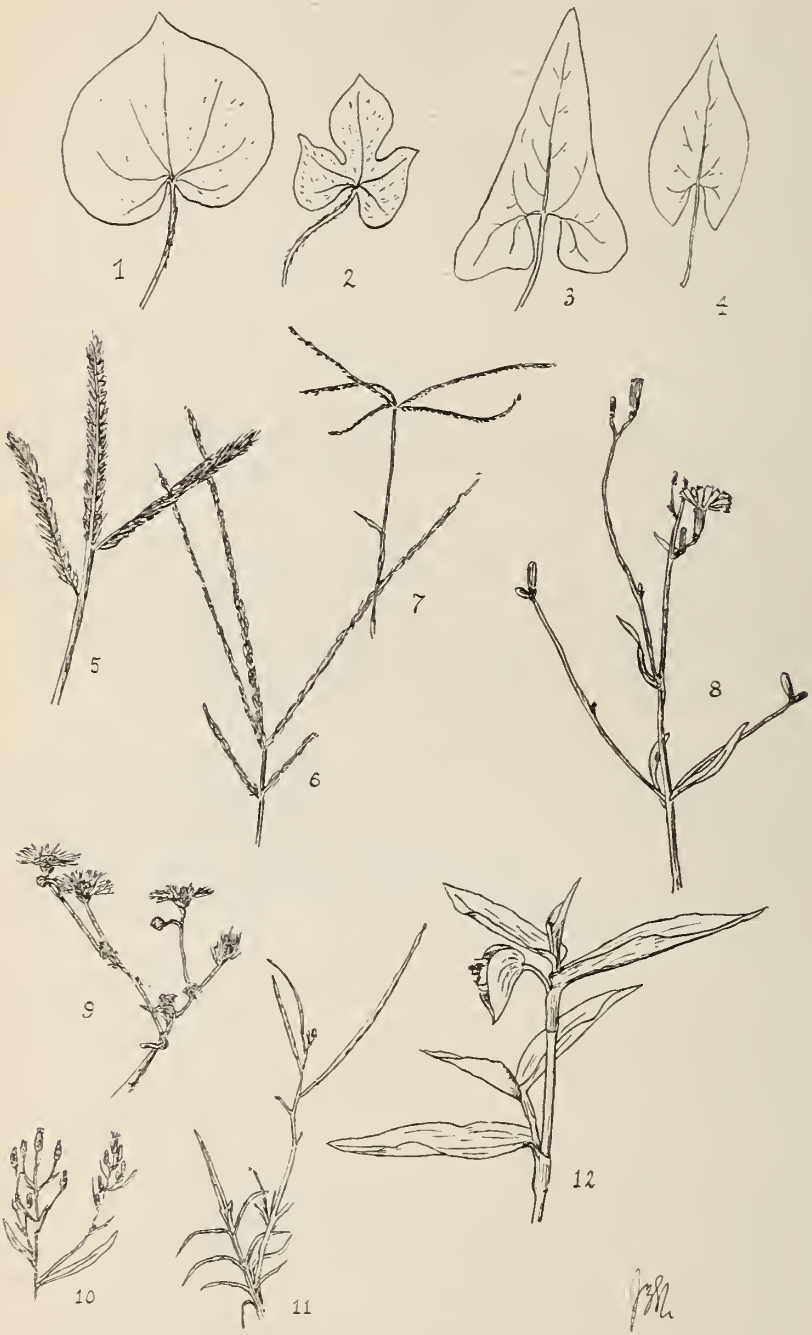


PLATE X.—Maryland Weeds. (Original).
1.—Morning glory (I. purpurea). 2.—Morning glory (I. hederacea). 3.—Hedge bindweed. 4.—Black bindweed. 5.—Yard grass. 6.—Crab grass. 7.—Bermuda grass. 8.—Skeleton weed. 9.—White-top flowers. 10.—Horseweed. 11.—Tumbling mustard. 12.—Day flower.

89. CRAB GRASS (*Digitaria sanguinalis*), the most common and difficult of the annuals, is recognized by the slender, one-sided spikes, 3 to 15 in number, on a slender main stem. It seeds abundantly even on very short stems near the ground when cut low. It produces an abundance of roots when very young and roots wherever the stem joints touch the ground. The seeds do not germinate till early summer, so that it is a pest only in summer and fall. Thorough late tillage is necessary to keep it down and a spell of wet weather will give it an advantage that is only overcome by frost, which kills it quickly.

It almost replaces blue grass during the summer on most lawns. A good stand of blue grass and frequent mowing to prevent crab grass from seeding is the best means of keeping it down. Allowing the grass to grow tall and mowing close with a scythe before the first crab grass seeds are formed is recommended by some. It is used as a hay and forage grass in the south.

Some other species of Digitaria are common as weedy grasses especially in sandy land. They have more slender spikes and stems than the common crab grass. Plate I, 1; VII, 1; X, 6.

90. RAGWEED (*Ambrosia artemisiifolia*). This is one of the few bad weeds native to this country. It is found everywhere on grain stubble, often making a perfect cover in summer. It causes bitter milk when eaten by cows. It is well known by the much divided leaves and long spikes, with abundance of pollen. It is an annual to be got rid of chiefly by clean cultivation and preventing seeding by mowing, cutting high enough not to hurt the grass if in young meadows and by early plowing of stubble. The seeds with several points at one end are frequent in American clover seed and many live several years in the soil. Plate V, 5.

91. SMARTWEEDS belong to the genus *Polygonum* which includes several other common weeds, all those troublesome here being annuals and to be controlled by clean cultivation and prevention of seeding and the use of clean seed. The seeds mature in a few days after bloom and ripe seed may be in the head with yet unopened buds. They are common in clover seed.

The two commonest smartweeds are *Polygonum Persicaria* (LADY'S THUMB), with hairs around the edge of the stipular sheath, and *Polygonum Pennsylvanicum*, without them. Both have dense spikes of small pink flowers and flat or three-sided seeds.

92. WILD GARLIC (*Allium vineale*). This is the only plant with onion-like scent common in fields. It produces an abundance of bulbs or sets deep in the soil and a cluster of bulblets in place of seed. There are two types of underground sets, one with a hard coating and capable of living for a long time in the soil and softer ones which usually produce the next year's growth. These methods of propagation spread it freely and permanently and the disagreeable flavor it imparts to milk from cows grazing in fields where it grows and to flour from wheat containing the bulblets, make it a most formidable pest to dairymen and grain growers.

It is probably scattered chiefly by the bulblets in seed grain but seeds are sometimes produced. It can be removed from wheat by fanning, preferably after drying. It can be kept down in fields by deep fall plowing to prevent winter growth of leaves, followed by a smothering crop. In a field on the Experiment Station farm plowed last December, garlic is entirely absent while it is very abundant on adjacent parts of the field plowed in the fall.

J. T. Rogers in a letter to J. W. Barker of Harrisburg, Pennsylvania, tells of farmers getting rid of garlic by growing oats for three years in succession.

93. WILD CARROT (*Daucus Carota*) is well recognized by the finely divided leaves, and flat-topped umbels of many, small, white flowers or the central one dark purple. The seeds are common in clover seed and are distinguished by the white prickles in lines along one side of the flat seed. They germinate one year and flower the next, so that late plowing gets rid of them for the following year, or clean culture at any time. The plants may be cut or pulled

before blooming if it is desired to secure clover or grass seed free from them. If mown they stool from the base and seed again so that several cuttings would be necessary. Plate IV, 2.

94. SORREL (*Rumex Acetosella*) is a low plant with succulent, smooth, arrow-shaped leaves, panicles of small, green or reddish flowers, and running rootstocks from which it buds and grows freely, making it very difficult to eradicate. The dull, rough, roundish, 3-sided seeds are common in clover seed, especially alsike. In soil that needs lime or in poor sandy soil it will almost replace the grasses and clovers, but in fertile soil in good condition these crops will keep it down. Where it is well established, clean cultivation for a year or two may be necessary to reduce it. Like most strongly acid plants, the leaves are very quickly killed by chemical sprays. Plate I, 6.

95. PLANTAIN. The plantains are well known by the broad, oval, ribbed leaves lying close to the ground. Our most common plantain is *Plantago Rugelii* (Plate IV, 3), with petioles crimson at base, and seed pods twice as long as thick. *Plantago major* is frequent, especially in lawns, and has smaller leaves, more dense spikes and the small pods not much longer than thick. The seeds of both are black, or nearly so, and irregularly angled, looking much like broken particles of dirt. They are very common in clover seed.

Plantain is one of our worst weeds in grass land and becoming worse the older the field. On lawns it can be removed by hand or by treating each plant with carbolic acid, salt, etc. Fields can be cleaned only by two or three years clean cultivation to destroy the seed in the soil and then when clover or grass is sown see that it is free from plantain seed.

The strong fertilizer sprays applied in dry weather if the crop is low enough that the plantain can be reached, will kill most of it without injuring timothy but may kill some clover.

96. OX-EYE DAISY (*Chrysanthemum Leucanthemum;* practically all the ox-eye daisy here is the variety *pinnatifidum*). This plant has a few slightly lobed, dark green leaves, mostly near the ground, and handsome flower heads 1½ to 2 inches across with white rays and yellow center and on stems 1 to 2 feet high. It is perennial by short rootstocks and is best eradicated by clean cultivation and sowing seed free from it. It is a bad weed in grass and clover, being much worse on poor soil. Mowing early will prevent seed formation, and spraying with strong iron sulfate when in bloom will kill most of the plants if the leaves can be reached by the solution. Plate VI, 3.

97. CHICKWEED (*Stellaria media*) is a low plant with opposite, nearly heart-shaped leaves, growing chiefly in fall and spring but remaining green and even blooming in winter. The very small flowers apparently have 8 or 10 minute white petals. With our warm winters this weed often almost crowds out young alfalfa and is a bad pest in wheat and particularly in strawberries and other low crops. Late cultivation if it can be practiced will get rid of it before winter. Spraying with iron sulfate in winter is considerable help in alfalfa, wheat and strawberries but weather conditions are then often unfavorable for the best results. The spray is most effective on the young seedlings in the fall, usually about the first of November. Plate II, 4; XI, 2.

98. PIGWEEDS (*Amaranthus hybridus* and *A. retroflexus*). The pigweeds with their dense clusters of small flowers, mixed with pointed scales, and red roots are typical annual weeds ever present in the best of cultivated soils, springing up early and late, growing rapidly and producing enormous quantities of small seeds. They are easily killed by cultivation but it is not usually continued late enough to prevent reseeding. Plate II, 3 (*A. retroflexus*).

99. WHITE-TOP (*Erigeron annuus* and *E. ramosus*), also known as DAISY FLEABANE, is one of the worst meadow weeds, well known by the tall flat-topped clusters of many small daisy-like flower heads, the first named having broader ovate, more toothed and more hairy leaves than the latter.

The seeds are very small and light and somewhat suited for being carried by the wind. They should be easily cleaned from seed. They are winter annuals germinating in the fall and completing their growth early the next summer. Dry weather in the fall is unfavorable to their germination.

Spraying with iron sulfate will kill most of it. Mow early before the seed is ripe if possible. Plate X, 9.

100. LAMB'S QUARTERS (*Chenopodium album*), a tall annual weed, common in rich cultivated land, easily known by the shining mealy appearance of the somewhat triangular, toothed leaves, and producing thousands of small green flowers, each with a single seed, is much like the pigweeds in habits and is to be combatted by thorough cultivation to destroy all plants, especially in late summer and autumn. Plate II, 2; VII, 4.

101. STICK-TIGHTS and SPANISH NEEDLES (*Bidens frondosa, B. vulgata and B. bipinnata*). These are annuals with inconspicuous composite flowers and divided leaves, common especially in moist fields. The first two have dark, flat seeds with two barbed prongs at one end (Plate VII, 1), the third (Spanish needle) has long, four-sided seeds with three or four barbed points.

They are particularly disagreeable weeds on account of the seeds (or more properly achenes) adhering to all clothing or the hair or wool of animals that touch them, thus scattering the seed as well as contaminating wool, etc.

They can be fought by late cultivation or cutting by hoe or scythe before seeding in late summer; drainage in wet fields would be helpful.

102. BRIARS, DEWBERRY, BLACKBERRY (various species of *Rubus*). These plants, with biennial, prickly, woody stems and edible berries, are usually bad pests only on old fields and along fence rows and roadsides. The recurved spines by which they climb make them very disagreeable to handle and they harbor the orange rust so destructive to cultivated blackberries and raspberries. They are destroyed by cultivation and on uncultivated land are best kept down by mowing and burning late in summer and by close pasturing to keep down young growth in spring. If it is desired to cultivate the land, after mowing and burning, plow late in the fall, harrow well in spring and follow by a thoroughly cultivated crop.

103. WINTER CRESS. There are three species of winter cress common in Maryland fields. *Barbarea verna*, with 10 to 16 lateral lobes to the leaf, is perhaps the most common, though the others, *Barbarea vulgaris*, (Plate III, 5; IX, 1) with 2 to 8 lateral lobes and pods on spreading stalks and *Barbarea stricta* with similar leaves and pods appressed to the main stem, are more abundant locally. *B. verna* is much used for greens and sometimes cultivated under the name of SCURVY GRASS. All have yellow, mustard-like flowers and long, slender pods. The name WATER CRESS should not be applied to these plants; water cress is a low or floating, white-flowered plant, found only in streams or ditches or on their borders.

The winter cresses may be destroyed by late fall plowing or cultivating, or by 20% iron sulfate spray in fall or spring, perhaps the best time being just as the first blossoms begin to open, spraying on a bright, warm day. If your farm is free from cress look out for it in clover and grass seed. If the plants are few and scattering, they may be cut by hand, but seed will ripen after cutting if they are in bloom.

OTHER IMPORTANT WEEDS OF GENERAL DISTRIBUTION.

This includes weeds mentioned in some lists of the 10 worst weeds but not in enough to come in the first class. In general they are given in order of their importance to most farmers.

104. RIPPLE (*Plantago lanceolata*). This well known narrow-leafed plantain is one of the worst weeds of poor grass land, and is one of the most common adulterants of seeds. The seeds are smooth, brown and boat-shaped.

It makes good enough forage that its too common and abundant presence in hay is not an entire loss.

It can only be got rid of by cultivation and clean seed. On lawns it can be cut out by hand with difficulty if not too abundant. The thick rootstocks sprout up again if a piece is allowed to remain. Plate IV, 5.

105. PURSLEY (*Portulaca oleracea*) is a very common, quickly growing, succulent weed with small, quickly fading yellow flowers and minute seeds in a small capsule with a lid. Persistent cultivation is necessary to keep it down but it usually does little harm; and does best only in well cultivated, garden soil. The fleshy stems root easily and have enough water in them to ripen seed without connection with the soil.

106. DOCK. The common NARROW or CURLED DOCK is *Rumex crispus* (Plate II, 1) and our BROAD DOCK is *Rumex obtusifolius*. The narrow dock can easily be pulled when in bloom if the ground is soft; the broad dock breaks too easily for pulling and must be cut deep or grubbed. The seeds ripen quickly and may even mature after pulling. A tool for pulling them is sometimes used. Clean cultivation will easily eradicate them in short rotations.

107. MORNING GLORIES. The common, large flowered, purple, white or pink morning glory, with heart-shaped leaves is *Ipomoea purpurea* (Plate X, 1). Another common one is *Ipomoea hederacea* (Plate X, 2) with smaller, pale blue flowers and three-lobed leaves.

We also sometimes see in fields *I. coccinea*, with very small scarlet flowers, *I. lacunosa*, with very small white flowers and *I. pandurata*, a large rooted species with large white flowers with a purple tube, occurs chiefly in uncultivated land. The last mentioned can only be starved out by continually keeping the tops cut off until the large root is exhausted. The others are annuals and yield to cultivation, but none must be allowed to escape and produce seed late in the season. The seed may remain a long time in the soil without germinating. The bindweeds (147, Plate X, 3; XI, 1) with similar flowers are sometimes called morning glories.

108. BURDOCK (*Arctium minus*) is well known by the very large woolly leaves and small heads of purplish flowers armed with hooks on the outside which make it a pest in wool, horse's manes, etc. It is rarely common, except in waste places. It is easily eradicated by preventing seeding, as it is a biennial. The plants should be cut off below the crown with a hoe or spud.

109. FOXTAIL. The most common is the YELLOW FOXTAIL (*Setaria glauca*), with 5 or more bristles to each grain. GREEN FOXTAIL (*Setaria viridis*) is also common but has only 1 to 3 bristles to each grain. *Setaria verticillata*, in which the bristles of the head are rough is sometimes found. These grasses are related to and resemble the cultivated millet and Hungarian grasses. Foxtail is a very common weed in cultivated land, on stubble, in lawns, meadows and pastures. It is a summer annual, but grows so rapidly and roots so firmly that it is difficult to destroy. Frequent cultivation, till late in the season, mowing and burning or spraying to destroy the seed can be practiced. Any method that will induce the seed in the soil to germinate and destroy the very young plants is valuable.

110. HORSE NETTLE (*Solanum carolinense*) is a spiny perennial with potato like leaves, flowers and berries, but spreading chiefly by buds on the long, deep rootstocks. It is a bad weed particularly in pastures but will flourish even in cultivated land, and is an injurious and disagreeable plant in hay. It is as difficult to eradicate as Canada thistle. Starve out by persistent cutting off below the ground in cultivated land and by cutting and salting in pastures. It is rarely found in clover or grass seed and is probably scattered chiefly in manure. The seeds according to Oswald germinate perfectly after passing through animals. Plate IX, 4.

111. THISTLES. The thistles belong to the genus *Cirsium;* they have large, spiny, irregularly lobed leaves; large, often spiny, heads of purple flowers, and plumed seeds easily carried on the wind. Our most common one is the very spiny BULL THISTLE (*C. lanceolatum*), Plate XII, 2. Other species occur frequently. *Cirsium pumilum* is a low, stout thistle with very large heads, common in Garrett County. (See also CANADA THISTLE, 161).

The thistles, except Canada thistle, are chiefly weeds of pastures and waste places, are biennials and should be destroyed and prevented from seeding by cutting off at the ground before blooming.

112. JIMSON WEED (*Datura Stramonium* with white flowers and *D. Tatula* with purple flowers). These are rank, poisonous annuals with large funnel-shaped flowers and spiny pods; common chiefly in rich land about habitations and easily destroyed by cutting or pulling. Plate XIII, 3.

113. JAPANESE HONEYSUCKLE (*Lonicera Japonica*) is a climbing or trailing woody vine with opposite leaves, long, fragrant, white flowers turning yellow, and black berries. It was introduced from Japan and is now over-running fences and roadsides and spreading into fields. It is a very ornamental plant and is especially valuable for holding and covering banks and cuts, but fills the ground with running rootstocks, and roots so readily that it is very difficult to get rid of where it is not wanted.

Deep plowing and harrowing out the vines and roots, followed by a clean hoed crop will destroy it, though sometimes the plowing or harrowing has to be repeated a few times. Goat pasturing is effective where cultivation cannot be practiced. Carbolic acid, salt or other weed killers could be used on the roots along fences.

114. GOLDEN ROD. Many different kinds of golden rods occur in Maryland. They are tall, slender plants distinguished by the many, very small heads of yellow. composite flowers. *Solidago canadensis*, with long, rough hairy, 3-nerved leaves, *S. serotina*, a taller plant, with smooth, narrow leaves, and *S. nemoralis*, in sterile soil, with rough leaves, broader toward the apex are, the most common, but none are troublesome except in uncultivated land, where they are best controlled by mowing.

A narrow leafed golden rod with flat-topped clusters of flower heads is often abundant in fields in sandy lands.

115. MILKWEED (*Asclepias syriaca*) is a milky juiced plant with large, opposite leaves and dense clusters of fragrant dull purple flowers and large, warty pods with plumed seeds. It spreads in meadows and fields by very long propagating roots. Cutting or pulling several times a year will subdue it. The underground parts must be starved out and are generally too deep to reach with a plow.

A pink-flowered milkweed (*A. incarnata*) is common in wet land. (See Indian hemp, 146).

116. ST. JOHN'S-WORTS. The St. John's-worts are recognized by the opposite leaves with pellucid or black dots and yellow flowers with many stamens. *Hypericum perforatum* is the worst one. It is frequent in pastures, etc., and is a perennial, but easily eradicated. A smaller annual one (*H. mutilum*) is common especially in fields needing drainage and lime.

117. SHEPHERD'S PURSE (*Capsella Bursa-pastoris*), a winter annual of the mustard family with flat, triangular pods, troublesome chiefly in rich garden land, is easily kept down by cultivation.

118. SASSAFRAS (*Sassafras variifolium*), where troublesome in fence-rows and old fields can best be grubbed out, or kept from forming leaves by frequent cutting or pasturing or by the use of carbon bisulfid on the cut roots.

119. COCKLEBUR (*Xanthium canadense*, and other species) is a much branched, vigorously growing weed with broad, heart-shaped leaves and egg-

shaped, two-seeded burs covered with hooked bristles. Cockleburs are very troublesome weeds in cultivated land especially in rich, wet fields. They are annuals, but if they get a start, hoeing or pulling is necessary to prevent them from seriously crowding the crop. Plate VI, 5. 6.

120. Catnip (*Nepeta Cataria*), a tall, annual mint with whitish, scalloped, heart-shaped leaves, is a weed of waste places, easily eradicated by cultivation.

121. Dandelion (*Taraxacum officinale*), with its large heads of yellow, strap-shaped flowers, low in the grass, and later, balls of seed, each with a long-stalked, feathery tuft is too well known in lawns and pastures. The wind easily carries the seed everywhere so that if eradicated they are soon reseeded from other places. It is destroyed by cultivation, or on lawns, by carefully digging out the deep perennial root or killing it with chemicals. Instruments are made for pulling them. Spraying with iron sulfate, 4 or 5 times a summer, on bright days about two days after mowing, removed them from lawns according to experiments in North Dakota and Rhode Island, but spraying has not proved so successful here or at the New York Experiment Station. Plate VI, 2.

122. Velvet leaf (*Abutilon Theophrasti*), with large, velvety, heart-shaped leaves, yellow flowers and large capsules with a flat, many-pointed, star-like top, is a tall annual frequent in rich cultivated fields, and is exterminated by frequent cutting or pulling before seeding.

123. Beggar-ticks (Several species of *Desmodium* of which *D. canescens* is the most conspicuous). These are large, perennial legumes, the leaves with three leaflets and the flat pods breaking up into rounded or triangular joints and adhering to clothing, wool or hair of animals. They are chiefly troublesome for this reason. They are kept down by mowing or cultivation. Plate VIII, 11, 13-21.

124. Cinquefoil (*Potentilla canadensis*) is a low plant with strawberry-like leaves of 5 leaflets and with yellow flowers, common in old fields and subjected by cultivation. Plate III, 6.

125. Ironweed (*Vernonia noveboracensis*, etc.). A tall, purple flowered, wet meadow and pasture weed with long, narrow, alternate leaves; combatted by cutting and salting.

126. Great ragweed (*Ambrosia trifida*) is three to ten feet high, with broad, three-lobed leaves, and long, erect spikes full of pollen and with some reddish juice. It is found chiefly in rich, wet land. Cultivation or mowing, or spraying with iron sulfate when young will get rid of it.

127. Horseweed (*Erigeron canadensis*) is a tall, slender annual with many narrow, strong scented leaves and a branching cluster of very small heads of minute flowers. The strong stems are often missed by the cultivator but can easily be pulled. Late cultivation is necessary. Plate X, 10.

128. Black-eyed Susan (*Rudbeckia hirta*); the state flower of Maryland, with large, yellow-rayed heads with dark centers is conspicuous in meadows and old fields and pastures where grass has been sown. It is easily eradicated by cultivation and is rarely found here in new fields unless introduced in the seed. It can be pulled in meadows when in bloom but seed may ripen on the uprooted plants.

WEEDS VERY BAD LOCALLY.

The following are not found generally throughout the state but where they do occur may be worse than any of those previously mentioned. In places where they have not yet been seen, their introduction should be prevented by thorough destruction of any stray plants that occur.

129. SANDBUR (*Cenchrus carolinianus* and along the coast *C. tribuloides*) is an annual grass of sandy land, very disagreeable on account of the penetrating, barbed spines of the burs. Cultivation and burning over infested fields is the treatment for them.

130. NIMBLE WILL (*Muhlenbergia Schreberi*) is a low, diffusely branched, slender stemmed, small leafed grass, spreading freely in lawns, etc., by the wiry, underground stems. Cultivation is the best method of getting it out. On lawns it may be killed by covering for a while with boards or tarred paper. Plate VII. 2.

131. BERMUDA GRASS (*Cynodon Dactylon*). This and the last are the chief wire grasses of Maryland. It is a lower more wiry grass than nimble Will, spreading rapidly by the creeping stems. It has 4-or 5-fingered spikes like crabgrass but is lower and stouter. It makes a good turf and in the South is much used for pasture, but is extremely difficult to eradicte. It will live over winter only in the warmer parts of Maryland and rarely seeds.

It may be killed out by shallow, fall plowing and harrowing and a crop of rye or winter oats, following after cutting, by a thorough plowing and harrowing again and a dense summer crop like millet or cowpeas and a clean hoed crop next year to remove the stray plants; or by continual plowing, harrowing and hoeing. Plate X, 7.

132. CHEAT (*Bromus secalinus*, etc.) is a well known winter annual grass of grain fields. Practice thorough cultivation, clean seed, and pulling from the wheat if not too abundant. Cultivating after wheat will aid in getting rid of it.

133. COUCH GRASS (*Agropyron repens*) is a grass with tall, flat spikes or heads, and abundance of very persistent, yellowish, running underground stems or rootstocks by which it spreads rapidly. It occurs infrequently in Maryland but is eradicated with extreme difficulty. Seeding should be prevented by cutting before ripe, and the most practicable method of starving out suited for the particular case practiced (see methods under Canada thistle). It may take two or three years to get rid of it. Cates recommends disking frequently after midsummer. Cultivation with a spring tooth harrow and raking out with a horse rake is helpful. Small patches may be smothered out by covering with boards or tarred paper. Plate VII, 3; I, 3.

134. NUT GRASS (*Cyperus rotundus* and *C. esculentus*). These are grass-like plants, especially of wet sandy fields, with triangular stems and spreading underground by small tubers, but chiefly by seed. Drainage is helpful but starving out by careful hoe cultivation for two or more years is necessary for eradication. Someone has recommended geese for keeping the tops destroyed and hog pasturage for the roots.

135. DAY-FLOWER (*Commelina communis*). A perennial with brilliant blue flowers, resembling very much the cultivated WANDERING JEW, has become a very persistent weed in some gardens, etc. Pieces of the green plant are very resistant to drying and root readily. Digging out and removal of the plants and careful watch for freshly sprouting pieces, new seedlings or plants covered by the crop, or constant hoeing with a crop that will not hide the weed is necessary to prevent it becoming a great pest if it gets beyond control. Apparently the seed germinates only in the spring. For small patches boiling water is a very effective treatment. Plate X, 12.

136. STAR OF BETHLEHEM (*Ornithogalum umbellatum*), a bulbous plant with flat leaves and white, 6-pointed, star-shaped flowers, is almost as bad as garlic in a few places but fortunately has such limited means of spreading to other farms that it will hardly become a general pest. Cultivating and hoe-

ing to starve out the underground parts is recommended, especially at the time they are making most of their growth in the spring. The deep plowing recommended for garlic might also be tried.

137. GRAPE HYACINTH (*Muscari botryoides* and *M. racemosum*) sometimes becomes just such a nuisance as the last and can have similar treatment.

138. BLACK BINDWEED (*Polygonum Convolvulus*), an annual vine with buckwheat like leaves and seeds, often overruns cultivated crops on low land, matting them together with its twining stems. It should be fought by clean cultivation with cleaning up of fence-rows from which it often spreads. Harrowing grain when the bindweed first comes up, or plowing wheat stubble when it is bad is also recommended. Plate X, 4.

139. SPINY PIGWEED (*Amaranthus spinosus*) resembles the other pigweeds, but is redder and has two sharp spines at the base of each leaf. It is getting more common, especially around farm yards, and should be destroyed as soon as it appears on the place, before it is too late. It is an annual with abundance of seeds. Persistent clean cultivation throughout the growing season is necessary to secure destruction of all plants before they seed.

140. COCKLE (*Argostemma Githago*). This common, purple flowered weed of wheat fields, with narrow, opposite, silky leaves, may be removed by pulling from wheat fields when in bloom, and the seed may be separated from grain by an eight mesh to the inch sieve, but if any large cockle seed are left in the seed wheat there is a tendency to thus breed up a large-seeded cockle which cannot be separated by the sieve. Plate II, 5.

141. BUTTERCUP (*Ranunculus bulbosus* and *R. acris*) is becoming common in some meadows and lawns. The leaves are cut into several narrow, few-toothed lobes, and the flowers are a bright and shining yellow. Tillage will remove them, but cutting out by hand will be profitable when only a few are present. Plate II, 6.

142. FIELD PEPPERGRASS (*Lepidium campestre*) is becoming a bad weed in grass and grain in a few places in Maryland. It is a winter annual of the mustard family, has arrow-shaped leaves clasping the stem and small, two-seeded, spoon-shaped pods, maturing in May. Perfectly clean cultivation and clean seed for more than one year are necessary to subdue it. Plate IX, 3.

143. MUSTARD. Several species of *Brassica*, especially *B. nigra* (BLACK MUSTARD). *B, alba* (WHITE MUSTARD), *B. arvensis* (CHARLOCK) may be included here. They are often bad weeds especially in grain, the charlock being the most frequent. They are easily recognized by the conspicuous 4-petaled and 6-stamened, yellow flowers, slender, long beaked pods, large rough leaves, and small, spherical, brown seeds which live for years in the soil.

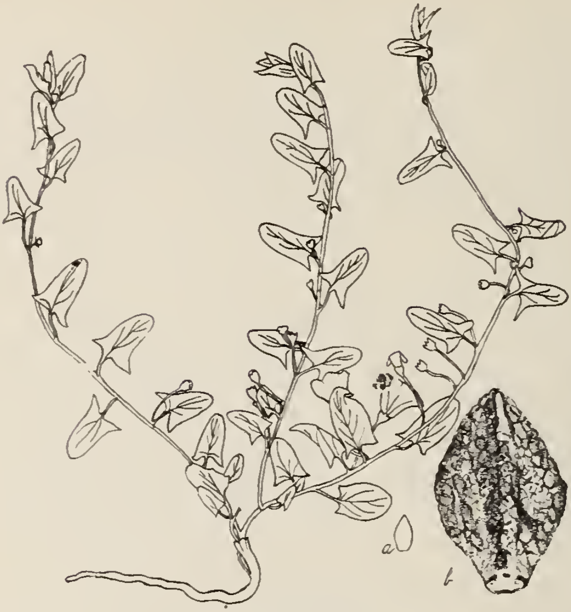
A limited quantity can be hand pulled from grain. Burning over the infested land and continuous cultivation in hoed crops is recommended by some. Spraying the grain fields just before the mustard blooms, with iron sulfate, 60-80 pounds to 50 gallons of water, using 50 gallons per acre, as recommended previously is a good practice when mustard is bad. Plate III, 1; IX, 2 (*B. arvensis*). Plate III, 2 (*B. nigra*).

144. RABBIT-FOOT OR WOOLLY CLOVER (*Trifolium arvense*), a small, narrow leafed, early blooming clover with small, soft silky, cylindrical heads, is a bad weed in strawberries on sandy land. It is a winter annual and can be controlled by very late or very early cultivation and to some extent by spraying in dry weather in winter with iron sulfate, 100 pounds to 50 gallons of water. Plate VIII, 39.

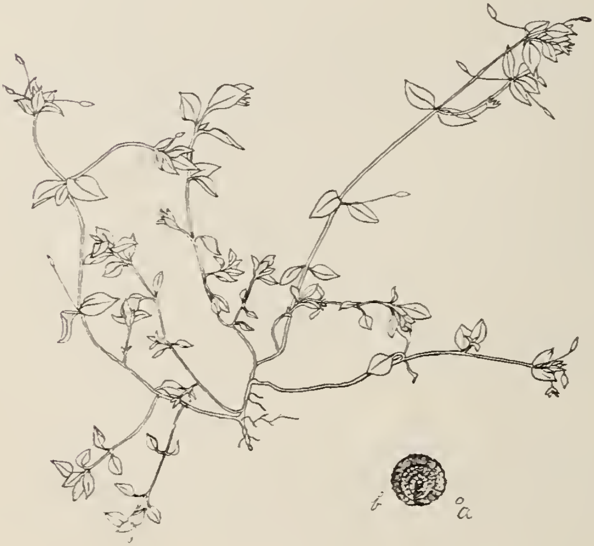
145. MALLOW (*Malva rotundifolia*) is a frequent garden weed with prostrate stems, roundish, scalloped leaves and small pink or white flowers, followed by a flat ring of seeds. The deep, tough, biennial root makes it dif-

ficult to kill out by hoe or cultivator, or by pulling, if it is allowed to get beyond the seedling stage, but by timely work it is easily eradicated.

146. Indian hemp (*Apocynum cannabinum*) is an erect milkweed with oblong leaves, small, greenish-white flowers and pairs of long, slender pods with silky, plumed seeds. The long, deep rootstocks cause it to spread persistently. It is not so common except in new ground or light or gravely soil near streams, but when present can be got rid of only by persistent cutting and salting or other starving out methods.



1.—Bindweed.



2.—Chickweed.

PLATE XI.—Bindweed and Chickweed (after Selby).

147. FIELD BINDWEED (*Convolvulus arvensis*) is a small vine with blunt pointed, arrow-shaped leaves, small, pink or white, morning glory-like flowers and perennial by extensive underground stems, any piece of which may start a new plant. Fortunately it is not common in Maryland as it is a great pest, climbing over all kinds of crops and matting them together and dragging them down, and is extremely difficult to control.

Cox recommends clean cultivation till the end of the growing season using implements that will scrape the soil or cut the weeds, rather than the shovel form of cultivator; or hog pasturing, or growing alfalfa for the frequent cutting and smothering effect. Plate XI, 1.

148. HEDGE BINDWEED. (*Convolvulus sepium*) is a much more common weed here, has larger flowers and larger, more pointed leaves, and needs similar treatment to the last. Plate X, 3.

149. DODDER (*Cuscuta Epithymum* and *Cuscuta arvensis*) is a slender, yellow, leafless vine growing on clover, alfalfa, etc. It is without roots and draws its nutriment from the plants to which it is attached. The dodder is often so inconspicuous that the first injury noticed is the barren circular spots in the field where the clover has been killed, and from which the dodder is still spreading.

Clover and alfalfa seed should be carefully examined by competent persons for dodder seed before it is sown. The seed appears almost wholly in imported seed and is not readily recognized.

When the dodder patches are not too abundant in the field they may be cut and removed or sprinkled with oil and burned. If very bad the field had better be plowed, and if cut it should not be used for seed; however, not much seed is produced here and dodder is largely killed out by winter though some of it lives over under protection near the ground. Plate V, 6.

150. BLUE-WEED (*Echium vulgare*) has rough bristly, narrow, mostly basal leaves, and a conspicuous spike of blue flowers. It is a bad weed chiefly in wheat, and also in meadows and pastures, and is best cut out with a hoe in spring before it is obscured by the crop, and then kept from seeding in the cultivated crop following. It is a biennial, most common in Washington and Frederick Counties and on limestone soil.

151. BUTTER AND EGGS (*Linaria vulgaris*), a low, erect plant perennial by abundant underground stems, and with numerous very narrow, smooth leaves and conspicuous, yellow, spurred flowers, is a weed in some farms in Western Maryland. Continuous cutting and deep cultivating, with the help of salting in pastures is necessary to starve it out. Plate V, 1.

152. MONEYWORT (*Lysimachia Nummularia*), a creeping plant with smooth, roundish, opposite leaves and conspicuous yellow flowers, and THYME-LEAFED SPEEDWELL (*Veronica serpyllifolia*), with similar appearance, except smaller, oval leaves and small, white or bluish flowers, form dense patches on lawns, completely crowding out the grass. They can be controlled by salting or spraying with any of the weed killing sprays in dry weather or if in small patches by covering with boards or tarred paper for a few weeks.

153. TRUMPET CREEPER (*Tecoma radicans*), a woody, climbing vine with scarlet flowers about 3 inches long, is frequently a bad weed on low land, especially in Eastern Maryland, and can be eradicated by repeated grubbing.

154. BUTTONWEED (*Diodia teres*), a small, erect annual with hard, ovoid fruit among bristles at the base of the narrow, opposite leaves, is a very abundant weed on sandy land but easily controlled by cultivation. It is killed quickly by sprays.

155. CHICORY (*Cichorium Intybus*), a large, erect perennial with large, composite heads of blue, strap-shaped flowers, is becoming common, having been introduced chiefly in European clover seed a few years ago. Careful

grubbing or frequent cutting and salting to starve out the deep roots is necessary. Plate XII, 4.

156. Skeleton-weed (*Chondrilla juncea*), much branched. almost leafless except for a cluster of lobed leaves at the base, with small, yellow, dandelion-like flowers, and perennial by a deep root, is a bad weed in many parts of eastern Maryland, especially in sandy land. The treatment is the same as for chicory, it may also be starved out by constantly keeping below ground with a hoe. Plate X, 8.

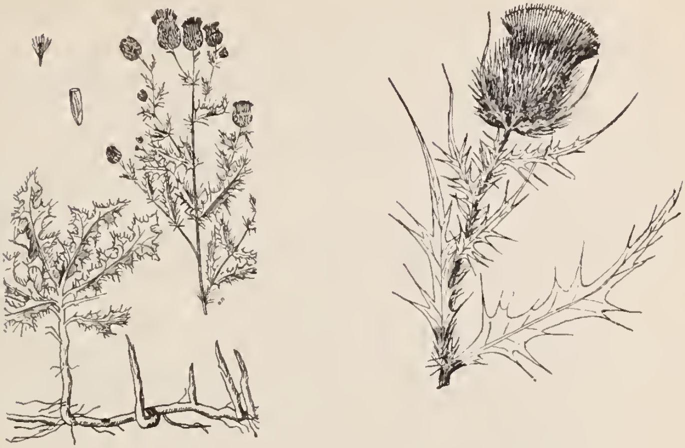
157. Prickly lettuce (*Lactuca scariola integrata*), when in bloom resembles the cultivated lettuce except for the narrow, stiffer leaves, somewhat prickly along the edge and midrib. It is common in some localities and spreads freely by the plumed seeds carried on the wind. It is subdued by clean cultivation and prevention of seeding by cutting before blooming. It is a biennial.

158. Spiny cocklebur (*Xanthium spinosum*) bears burs like the common cocklebur but the leaves are narrow and hoary and have three spines at the base of each. It is a bad plant, becoming more common, but fortunately slowly, and should be destroyed whenever found, by cutting off at the ground to prevent seeding and by clean cultivation on areas where it is introduced. Plate VI, 6.

159. Galinsoga (*Galinsoga parviflora*) is a low, branched, rapidly growing annual composite with very small, white-rayed heads and opposite, oval, hairy, toothed leaves. It is an abundant garden weed in rich soil and is kept down by thorough cultivation, especially in late summer to prevent seeding.

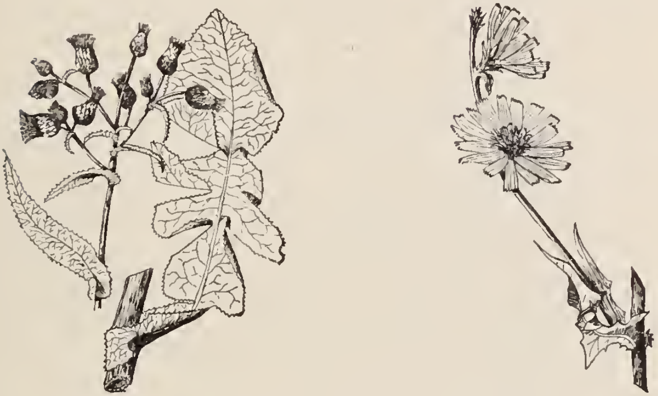
160. Dog fennel (*Anthemis Cotula*), an ill scented annual with finely divided leaves and many small, daisy-like flowers, is a vile weed, usually in waste places about farm building and yards, in some localities. It should be cut close before blooming. Mowing is effective where it grows on a large scale.

161. Canada thistle (*Cirsium arvense*) is like the other thistles except that the leaves are green, being almost free from wool, the purple flowered heads are numerous, not much over ½ inch thick, and there is an abundance of running, underground stems by which it propagates freely and which are very difficult to kill out. It rarely seeds much and is present only in a few places in Maryland, this being nearly the southern limit of its distribution. In small patches, repeated cutting (every week or more often) with the hoe and applications of salt or other chemicals is best. In large fields, summer fallow may be necessary, plowing shallow and harrowing in June, with cross plowing and harrowing again when a new growth appears, and the next year follow with a carefully hoed crop. If a crop is grown, then the field should be plowed and harrowed as many times as possible in the fall and in the spring before planting and kept absolutely clean while the crop is on the ground. Mowing twice a year just after the flowers open will keep it down but not eradicate it. Plate VI, 4; XII, 1.



1.—Canada Thistle.

2.—Bull Thistle.



3.—Sow Thistle.

4.—Chickory.

PLATE XII.—Thistles and Chicory (after Selby).

WEEDS OF LESS IMPORTANCE.

Some other weeds of less importance but which are sometimes inquired about are the following:

162. Mosses often occupy the ground on wet or shaded lawns. The ground should be limed, harrowed or raked, manured and new grass seed sown.

163. Paspalum (Several species). These are crab grass-like grasses but with tougher stems and leaves and larger, flat, round seeds on the one-sided spikes. They are often abundant in waste land and pastures, but are not much used by stock, and the seeds sometimes appearing as if popped out like small popcorn grains from the attacks of a possibly poisonous ergot. Controlled by cultivation.

164. Panic grass. Various species of *Panicum* are common and have small, one-seeded spikelets mostly on the ends of slender, much branching in-

florescence. One (*Panicum dichotomiflorum*) is a rank growing, succulent annual of rich, moist land. Thorough tillage keeps it down.

165. Tall red top (*Tridens flavus*) is a tall, coarse, tough grass with purple tops, the stem covered with a sticky substance, appearing in late summer in old fields and controlled by mowing or cultivation.

166. Broom sedge (*Andropogon scoparius, A. glomeratus*, etc.) the common, feathery seeded grass of old fields, reddish in winter; is easily destroyed by cultivation.

167. Yard grass (*Eleusine indica*), with 2-to 5-fingered, flat spikes wider than in crabgrass, and tough stems lying flat on yards and paths, should be cut out with a hoe before its seeds ripen. Plate X, 5.

168. Wormseed (*Chenopodium ambrosioides var. anthelminticum*) and related plants, with strong, aromatic odor and dense clusters of very small flowers with one minute, black seed from each, are easily destroyed annuals.

169. Black medick or yellow trefoil (*Medicago lupulina*) is a clover-like legume of some value, with heads of yellow flowers. The seeds are often used as an adulterant of alfalfa. Plate III, 4; Plate VIII, 4.

170. Bouncing Bet (*Saponaria officinalis*), a perennial of the pink family, with opposite, smooth, oval leaves and dense clusters of pale, rose-colored flowers is common in waste places in the mountain counties.

171. Mouse-ear chickweeds (species of *Cerastium*), white campion (*Lychnis alba*) and other weeds of the pink family are frequent and should be looked for in clover and grass seeds. They have not yet become important, except that the cerastiums are sometimes prominent in spring and can be treated as the ordinary chickweed.

172. Teasel (*Dipsacus sylvestris*) a tall biennial with opposite leaves, prickly stem and short cylindrical, long-awned heads, is frequent along roads and in waste places, especially in limestone land.

173. Sweet clover (*Melilotus alba*, with white flowers, and *M. officinalis* with yellow flowers). These are sweet scented, clover-like biennials with small flowers in slender spikes and are valuable weeds on poor land, being rich in nitrogen. Mowing, or otherwise preventing seeding, and cultivation destroy them. Plate VIII, 6.

174. Evening primroses (*Oenothera biennis, etc.*) are tall plants, with yellow flowers with 4 petals and 8 stamens, common in waste land and yielding readily to cultivation.

175. Ground ivy (*Nepeta hederacea*), a creeping perennial with round or kidney-shaped, scalloped, scented leaves and blue, mint-like flowers, is sometimes a pest on lawns and as difficult as Canada thistle to get rid of. Continuous cultivation is necessary. Frequent spraying is recommended for trial.

176. Dead nettle (*Lamium amplexicaule*) is a similar, more erect winter annual which is commonly seen in gardens in spring but is comparatively harmless.

177. Ground cherry. Several species of *Physalis*, recognized by the berries enclosed in inflated husks, infrequently occur as weeds and some, perennial by deep rootstocks, have to be starved out if they are doing any harm.

178. Mullein (*Verbascum Thapsus*), with its large woolly leaves and thick spikes of yellow flowers, and Moth mullien (*V. Blattaria*), with smooth, scalloped leaves and slender spikes of yellow or whitish flowers, are

rarely so abundant but that they can be cut out with a hoe or spud in fall or spring. Plate V, 4, (*V. Blattaria*).

179. Yarrow (*Achillea millefolium*), a meadow or pasture perennial, two to four feet high with small white heads in a flat-topped cluster and very finely divided leaves, is a frequent impurity in seeds but is rarely abundant in good soil. Plate VI, 7.

180. Corn chamomile (*Anthemis arvensis*), a common spring weed of cultivated fields and gardens, with low, daisy-like flowers and divided, slightly scented leaves, also occurs in grass and should be looked for in the seed. It is easily controlled by cultivation.

181. Asters (*Aster ericoides* and related species, variously known as Frostweed, Stickweed, Steelweed, etc.) are common on waste and sterile land, and are much branched, narrow-leafed perennials with hundreds of small daisy-like flowers in late autumn.

182. Fireweed (*Erechtites hieracifolia*) is a tall, rank-scented annual of clearings and burned land, with grooved, watery stem, and cylindrical heads of composite flowers. The seeds are easily carried on the wind by means of the abundant plume of white hairs.

183. Sow thistles (Species of *Sonchus*), are lettuce-like annuals with thick, yellow heads and leaves clasping the stem and slightly spiny margined, found about dwellings, etc., but rarely common or difficult to control. Plate XII, 3.

SOME UNCOMMON WEEDS TO BE LOOKED OUT FOR.

Several weeds that have become obnoxious in other places are appearing in Maryland. The wheat fields of Washington County seem to offer conditions favorable for European grain weeds and we find poppy, corn flower, etc., frequent. When the following or other new weeds likely to become injurious occur, any means to eradicate them should be used before it is too late.

184. Field poppy (*Papaver dubium*). The large delicate flowers and milky juice are unmistakable. They seed so abundantly that they may overrun fields but the few present can be destroyed now before they become common. It is an easily killed annual.

185. Johnson grass. (*Sorghum halepense*), a large, sorghum-like grass, with strong, creeping rootstocks by which it spreads and which make it very difficult to eradicate, is found in a few spots. Cates and Spillman recommend to pasture the infested fields and cut the grass every time it blooms and the next year plow shallow and cultivate clean.

186. Tumbling mustard (*Sisymbrium altissimum*), a winter annual with mustard-like flowers, very long, slender, diverging pods and finely divided leaves, is becoming frequent, especially in timothy seeds from the Northwest where it is a great pest. Plate X, 11.

187. Wild radish (*Raphanus Raphanistrum*) has strong scented, smooth, lobed leaves; yellow, mustard-like flowers with purple veins, and jointed pods with a broad beak. It is a winter annual or biennial and has appeared a few times in clover seed.

188. Tare. *Vicia sativa*, *V. angustifolia* and other vetches are occasionally seen; they have small, pea or bean-like flowers and pods, and climb by tendrils on the ends of compound leaves with a number of narrow leaflets each. Though of value as forage and as nitrogen gatherers, when not under control they have become pests in grain, etc.

189. Broom-rape (*Orobanche minor*) is a stout, leafless and rootless plant, without green color, attached to the roots of clover, etc. It grows about a foot high and produces an abundance of exceedingly small seeds. It has been seen only a few times in Maryland clover fields but is a great pest in Europe, where it comes from. The seeds may lie in the ground for years without germinating unless in contact with clover roots.

190. Bracted plantain (*Plantago aristata*). This has small flowers and seeds similar to ripple but with much narrower leaves and the longer heads with numerous projecting bracts. It is a frequent adulterant in grass and clover from the West, where it is a bad weed. It is a winter annual or biennial. Plate IV, 4.

191. Corn flower (*Centaurea Cyanus*), a blue flowered, annual composite, often cultivated under the names Bachelor's Button, Bluebottle, Ragged sailor or French pink, is seen frequently in Maryland grain fields and may become a pest as in Europe.

192. Ox-tongue (*Picris echioides*) has yellow, dandelion-like flowers on tall, branched stems, with bristly, mostly basal leaves. It is being introduced in imported seed, chiefly alfalfa, and should be looked out for.

A number of other uncommon species not named here occasionally occur and fields grown from imported seed should be watched. The railroad embankments recently sown to grass seem to be especially full of uncommon weeds either from the seed or the street sweepings used in preparation for seeding.

OTHER WEEDS.

A number of other weeds of minor importance are given in the key on pages 26 to 39 simply because they may occur and some one wish to know what they are.

193. *Weeds of water, ditches and wet places*: Sensitive fern (*Onoclea sensibilis*, Flowering fern (*Osmunda regalis*), cinnamon fern (*Osmunda cinnamomea*), cat-tail (*Typha*), pondweed (species of *Potomogeton*), eel grass or water celery (*Vallisneria*, the brackish water plant used for packing crabs, etc.), sedges (Various species of *Cyperus* and *Carex*), day lily (*Hemerocallis*), smartweeds (*Polygonum hydropiper*, etc.), tear-thumb (*Polygonum sagittatum* and *P. arifolium*, in ditches), cut grass (*Leersia*, in ditches, etc.), yellow cress (*Radicula sylvestris*), touch-me-not (*Impatiens*), peppermint and spearmint (*Mentha*), bugle weed (*Lycopus*), monkey flower (*Mimulus*), water willow (*Dianthera*, along rocky streams in western Maryland), elder (*Sambucus*), climbing hemp-weed (*Mikania*), Joe-Pye weed (*Eupatorium purpureum*), thoroughwort (*Eupatorium perfoliatum*), *Eclipta*.

194. *Annual (or biennial) field weeds*: Barnyard grass (*Echinochloa*), annual blue grass (*Poa annua*), stink grass (*Eragrostis magastachya*), wild barley and squirrel-tail grass (*Hordeum*), carpet weed (*Mollugo*), many small plants of the chickweed family (*Silene antirrhina*, with viscid stems, *Spergula*, *Sagina*, *Stellaria*, *Arenaria*), knawel (*Scleranthus*), corydalis, ball mustard (*Neslia*), peppergrass (*Lepidium virginicum*). hare's-ear mustard (*Conringia*), mouse-ear cress (*Sisymbrium Thalianum*), whitlow grass (*Draba verna*), false flax (*Camelina*), partridge pea (*Cassia*), wild bean (*Strophostyles*) Plate VIII, 32, 35, cranesbill (*Geranium*), storksbill (*Erodeum*), three-seeded mercury (*Acalypha*), milk pursley and other spurges (*Euphorbia*), flower-of-an-hour (*Hibiscus Trionum*), gromwell (*Lithospermum*), black nightshade (*Solanum nigrum*), blue curls (*Trichostema*), speedwell (*Veronica*), Venus's looking glass (*Specularia*), dwarf dandelion (*Krigia*).

195. *Perennials of grass land, etc.*: Sweet vernal grass (*Anthoxanthum*), rye grass and barnel (*Lolium*), some perennials of the chickweed family (*Silene, Saponaria Vaccaria, Lychnis*), Indian strawberry (*Duchesnea*), burnet (*Sanguisorba*), gum plant (*Grindelia*, rare in grass from western seed).

. 196. *Weeds chiefly of waste or sterile land, roadsides, woods, etc.*: Brake (*Pteris*), pine, poverty grass (*Aristida dichotoma*), wild oat grass (*Danthonia spicata*), Canada blue grass (*Poa compressa*) Plate I, 5, rush (*Juncus tenuis* is the common one along paths), asparagus (wild plants communicate the rust to cultivated plants), stinging nettle (*Laportea* in low woods, or occasionally species of *Urtica* near habitations), yard weed (*Polygonum aviculare* and *P. erectum*), Deptford pink (*Dianthus Armeria*), crowfoot (*Ranunculus*), horn poppy or sea poppy (*Glaucium*, along the coast), celandine (*Chelidonium*), fumitory (*Fumaria*), several weeds of the mustard family, live-for-ever (*Sedum*), clammy weed (*Polanisia*), spider-flower (*Cleome*), cinquefoil (*Potentilla monspeliensis*), agrimony (*Agrimonia*), Scotch brooom (*Cytisus*, sandy land in Anne Arundel Co.), wild senna (*Cassia Marilandica*) Plate VIII, 34, wild indigo (*Baptisia*) Plate VIII, 1, 2, yellow clover (*Trifolium agrarium*) Plate VIII, 37, hop clover (*Trifolium procumbens*) Plate VIII, 38, crown vetch (*Coronilla*), lupine (*Lupinus perennis*) Plate VIII, 36, bush clover (Plate VIII, 12, 22-27) and Japan clover (*Lespedeza*) Plate VIII, 25, yellow wood sorrel (*Oxalis*), spurges *Euphorbia*), sida, St. Peter's-wort (*Ascyrum*), orange grass (*Hypericum gentianoides*), pinweed (*Lechea*), violet (*Viola*, several species), waxweed (*Cuphea*), meadow beauty (*Rhexia*), willow herb (*Epilobium* often in burned places), evening primrose (*Oenothera* species), gaura (*G. biennis*), fennel (*Foeniculum*), angelica, persimmon (*Diospyrus*), hound's tongue (*Cynoglossum*), beggar's lice (*Lappula*), comfrey (*Symphytum*), vervain (*Verbena*, 3 species) Plate IV, 1, mountain mint (*Pycnanthemum*), horsemint (*Monarda*), basil thyme and basil (*Satureja*), pennyroyal (*Hedeoma*), heal-all (*Prunella*) Plate V, 2, horehound (*Marrubium*), hedge nettle (*Stachys*), motherwort (*Leonurus*), elatine (*Linaria Elatine*), toadflax (*Linaria canadensis*), gerardia, figwort (*Scrophularia*), *Plantago Virginica*, bluet (*Houstonia*), field madder (*Sherardia*), bedstraw (*Galium*), wild lettuce (*Lactuca*), rattlesnake-weed (*Hieracium venosum*), elephant's foot (*Elephantopus*), various *Eupatoriums* (thoroughwort, etc.), golden aster (*Chrysopsis*), heterotheca (*H. subaxillaris*, in sandy Eastern Shore fields), white-topped aster (*Sericocarpus*), various white-leafed everlastings (*Antennaria, Gnaphalium, Gifola*), elecampane (*Inula*, mountains), Jerusalem artichoke and other sunflowers (*Helianthus*), crownbeard (*Verbesina*), feverfew (*Chrysanthemum Parthenium*), tansy (*Tanacetum*), groundsel (*Senecio Balsamitae*).

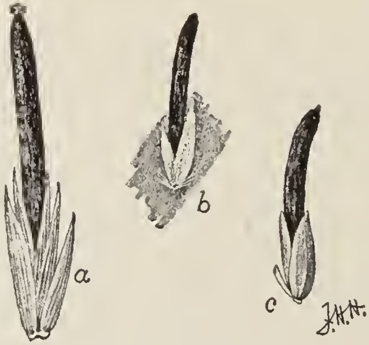
DANGEROUS CULTIVATED PLANTS.

197. Some cultivated plants not mentioned elsewhere that may become weeds are the following:

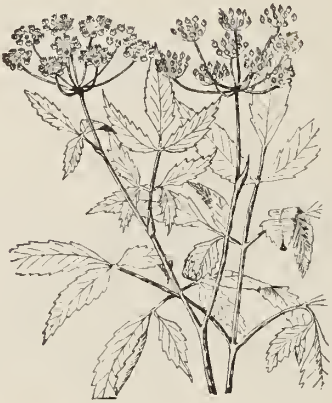
Rye may become a weed in wheat and buckwheat in the crop that follows it. Johnson grass is sometimes sown and is a good grass but eradicated with extreme difficulty. Osage orange grown for hedges is one of the worst sources of infestation for San Jose scale, draws on much useful ground on both sides, and is difficult to eradicate even by grubbing, as the roots keep throwing up sprouts. *Kochia scoparia*, a bushy annual resembling a small evergreen, is becoming established locally as a weed, as is also prince's feather.

198. Some plants that tend to form thickets or invade lawns by sprouting from the roots are: Silver poplar, paper mulberry, some willows, Japanese knotweed (*Polygonum cuspidatum*), some plums and cherries, English elm, sumachs, blackberries, wineberries, raspberries, black locust, ailanthus.

Many other trees if cut tend to throw up sprouts from the roots. August is generally the best time to cut to reduce the sprout production. See experiments with chemicals on page 16.



1.—Ergot. (After Beal.)



2.—Water hemlock (after Selby).

Jimson weed seed (after Beal).

PLATE XIII.—Poisonous plants.

POISONOUS PLANTS.

For the welfare of both human beings and domestic animals a knowledge of poisonous plants is important. A great many plants, some in common use, are injurious if taken internally while a few are poisonous by contact. Children are apt to be poisoned through ignorance, and the value of a correct knowledge of the common plants and their properties should be emphasized and some study of this kind encouraged. In childhood such knowledge can be easily gained, and with more interest, as the natural curiosity is keener, and in later life other things occupy the attention. Children should be trained not to eat unknown fruits or roots.

Fortunately there is little trouble to stock from poisonous plants in this region. The loco and many other dangerous plants of the West are absent and the abundance of good forage leaves little inducement to eat dangerous vegetation.

In the small space of this bulletin only the more important poisonous plants can be discussed. But mention will be made here of some others known to be poisonous or suspected so that readers can be on guard against them. A great many innocent plants may occasionally do harm to certain persons, even strawberries are poisonous to some.

The works of Chesnut, Pammel and others have been used in making the following list:

199. Beginning with plants lowest in organization; some of the green and blue-green water-scum organisms (algae) give off offensive odors and are suspected of being injurious. They can be destroyed in water by those who have expert knowledge of the methods, by the use of minute quantities of copper sulfate or other poisons.

200. The bacteria, although the smallest of plants, contain some of the most dangerous as they cause most destructive diseases by forming poisons in the living bodies of man and other animals (diphtheria, tetanus, etc.). Others decompose foods and form poisons (ptomains, etc.).

Some, like the soil bacteria, are of course essential to agriculture.

201. The mushrooms contain the most deadly poisonous plants. *Aminita phalloides*, *Aminita muscaria* and other species of aminita are the worst. The aminitas are recognized by the cup or ring at the base of the stem and by the gills beneath the cap being always white. Of the 500 or more kinds of mushrooms found in Maryland there are not over a dozen really poisonous and not more than that many that are really good eating. There is no one way to tell toadstools from edible mushrooms, and unless one knows thoroughly the good kinds he should avoid all.

202. Some molds are known to cause disease in animals (barber's itch, ringworm, etc.). Others are suspected of connection with pellagra. Most of the common molds are comparatively harmless.

203. The smuts and rusts of grain, etc., are not certainly poisonous but as dust in the air may cause inflammation of the mucous membrane in sensitive persons. The ergots of rye and various grasses are quite poisonous, Plate XIII, 1.

204. Practically all plants belonging to the family represented by the Indian turnip, calla, elephant ear, and skunk cabbage are acrid poisonous, though most of them are harmless after cooking.

205. Another large-leafed plant of our swamps, the hellebore has quite poisonous seeds and, to a less extent, leaves.

206. Lily of the valley is very poisonous.

207. Poke root is very poisonous.

208. Cockle seeds are considered especially poisonous to poultry, but they are rarely eaten even when fed with wheat. Other members of the pink and chickweed family are no doubt somewhat poisonous. Plate II, 5.

209. The baneberries, larkspurs, aconite, etc., growing wild or cultivated in Maryland contain dangerons alkaloids. The buttercups (Plate II, 6), species of clematis and others of the buttercup family contain very acrid juice which may even blister the skin.

210. The roots and leaves of the May apple are very poisonous, though the fruit is sometimes eaten.

211. Mustard (Plate III, 2), horse radish and other members of this family usually give sufficient warning themselves, not to use them in excess.

212. The wilted leaves of cherries, especially the wild cherry and choke cherry, contain hydrocyanic acid, one of the most fatal poisons known. It is also very easy to produce this poison from apple seeds, peach seeds and leaves, etc.

213. Many plants of the legume family (Plate VIII) contain poisonous alkaloids or glucosides. Those especially to be avoided, which are wild or cultivated here, are leaves and fruit of Kentucky coffee-tree, wild indigo, Sophora Japonica, Scotch broom, lupines, rattle-box, goat's rue, scarlet runner. The root, leaves and bark of the common black locust are poisonous if eaten. Wilted lima bean leaves are said to cantain hydrocyanic acid.

214. The seeds of castor bean contain a deadly poison. The juice of some of the small milkweeds belonging to the same family is strong enough to cause inflammation of the skin. One of these, the snow-on-the-mountain, often grown for ornament, has even been used for branding cattle. Another euphorbia, the cultivated spurge, as no doubt others, has poisonous seeds.
The cultivated box is a well known poisonous plant.

215. The sumach family contains the only plants conspicuously poisonons by contact. These are the poison ivy, poison or swamp sumach, and poison oak. If the juice of these plants, even in very small quantities comes in contact with the skin, watery pimples or often severe swelling is produced. Some persons are much more susceptible than others, while some seem to be entirely immune. There is not sufficient evidence that poisoning can take place without actual contact with the juice, or that the trouble will recur without a second contact, although there are many apparent cases of both.

The common poison ivy (*Rhus Toxicodendron*) is a vine, or often shrub-like, with leaves divided into three broad, pointed, toothed leaflets; numerous fine, climbing rootlets along the stem, and clusters of small, white berries remaining on over winter. The poison sumach (*R. typhina*) is a shrub, found in swamps, with smooth, light colored bark, large, thick twigs, 7 to 13 leaflets to each leaf and berries as in poison ivy. The poison oak (*R. quercifolia*) is found in our dry, sandy woods, it is only a few feet high, otherwise like the poison ivy, except that the leaves are more lobed and oak-like and more hairy.

Poison ivy can be eradicated by cutting off below ground and applying salt, carbolic acid or other weed killing material at the root. The usual treatment in case of poisoning is to wash the affected skin in alcohol to remove the poisonons substance, then bathe with lead acetate solution.

216. Cotton seed meal in excessive amounts is injurious, especially to hogs.

217. St. John's-wort is said to cause blisters on the white haired skin of horses but not on the darker colors. The same effect has been found from horses feeding on alsike clover.

218. The parsnip and carrot family contains a number of important poisonous plants. The most notable one is the poison hemlock, with large, finely divided leaves, a head of carrot-like flowers, and spotted stems. The whole plant is very poisonous. It was used by the ancient Greeks for putting to death criminals and others. The hemlock is occasionally found wild in Maryland around habitations. A much more common plant, also very poisonous, is the water hemlock (Plate XIII, 2), with similar flowers and coarser divided leaves and having tuberous roots. It is common in our wet lands, and cases of poisoning are frequent.

All the members of this family should be used with caution. There are cases of poisoning even from parsley, parsnip, celery and carrot. All contain volatile oils, especially in the leaves and seeds, which are least irritating to the skin.

219. Many of the plants, mostly shrubs, of the heath family, to which our laurel, blueberry, azalea, etc., belong, are quite poisonous. The evergreen forms like laurel and rhododendron are especially apt to be eaten in winter by sheep or other animals and often cause their death. The narrow leafed laurel or lambkill is occasionally found, the broad leafed laurel is one of our commonest evergreens. The trailing arbutus and stagger bush (*Lyonia mariana*) are thought to be poisonous.

220. Among the primroses, *Primula obconica*, often used as a house plant, is one of the few plants that effect the skin if handled much. Another house-plant of this family, the cyclamen, contains an internal poison, as also does the inconspicuous weed, *Anagallis arvensis*, or pimpernel.

221. The common privet, forsythia, and possibly some other members of the same family should not be eaten. Children have been poisoned by privet according to Chesnut.

222. The common oleander is very poisonous.

223. The potato family contains many very dangerous plants. The common black nightshade is poisonous, especially the green parts. However, the berries are often eaten and varieties are cultivated for that purpose. The green parts of potatoes and tomatoes are more or less poisonous; green tubers should not be used as food. The bittersweet and probably the horse nettle (Plate IX, 4), both belonging to the same genus as the potato, are quite dangerous. Jimson weeds (Plate XIII, 3) are very poisonous; children seem prone to eat the seeds and are frequently killed by them, but the foliage is also narcotic. The cultivated daturas are quite similar. The extremely poisonous plants, belladonna or deadly nightshade and henbane are but rarely found here. Other plants of this family to be careful of are ground cherry, egg plant, matrimony vine and red peppers. It is hardly necessary to mention tobacco, though it is well known to contain one of the most deadly poisons known; its use for the effect of this drug is so common that serious results to adults are not frequent.

224. Foxgloves, one of our common flowers, are very poisonous, and some of the wild species of the same family such as mullein (Plate V, 4), butter and eggs (Plate V, 1), species of gerardia, figwort, lousewort, cow wheat, and Culver's root are to be used with caution.

225. Indian tobacco (*Lobelia inflata*), is quite poisonous, and other lobelias more or less so.

226. Animals have been poisoned from eating young cockleburs. Species of erigeron (white top, horseweed) are strong irritants (Plate X, 9, 10). Sneezeweed, frequently seen in our low, sandy land, is poisonous to animals.

227. Among other plants that have an unsavory reputation, but from which bad results are not common, may be mentioned the following: Some ferns, if eaten (e. g. maidenhair); horsetail; cedar, especially the oil; millet and Hungarian grass, said to be poisonous to horses; many bulbous plants of the lily family, asparagus, sometimes blisters the skin; root of blue flag; black walnut, leaves and juice; Osage orange; hemp; stinging nettles; oxalic acid compounds in sorrel and docks, may be injurious; buckwheat, may cause a rash; smartweeds, very acrid; moonseed berries; sassafras berries (?); poppies, may contain morphine, etc.; bloodroot; celandine; fumitory; hydrangia, philadelphus and deutzia, contain saponin; Indian physic; strawberries, to some persons; mountain ash berries; wood sorrel and other oxalis; flax seed to hogs; rue; ailanthus, or tree-of-heaven; bitter-sweet; wahoo and other species of evonymus; holly berries; herbage and seeds of buckeye and horse chestnut; both wild and cultivated species of impatiens (balsam or touch-me-not); various species of buckthorn; Virginia creeper, may be rarely poisonous; possibly velvet leaf; violets, slightly; daphne and leatherwood, shrubs sometimes cultivated for ornament, are quite poisonous; dogwood berries, possibly; all milkweeds, butterfly weed and Indian hemp; wild morning glories, and bindweeds of the same family (Plate X); heliotrope; blueweed; ground ivy, to horses; probably many of the mints containing strongly fragrant oils, if taken in excess; trumpet creeper; buttonbush; various members of the honeysuckle family, including elder and Japanese honeysuckle; wild lettuce; some golden-rods; yarrow; dog fennel and its relatives; tansy; wormwood; burdock; thistle.

"A man of words and not of deeds
Is like a garden full of weeds."

INDEX.

Abutilon, see velvet leaf.
Acalypha, see three-seeded mercury.
Achillea, see yarrow.
Aconite, Aconitum, ...32, 62
Actaea, see baneberry.
Adam-and-Eve, ...4
Adiantum, see maidenhair.
Aesculus, see buckeye, horse chestnut.
Agrimonia, agrimony, ...37, 59
Agropyron, see couch grass.
Agrostis, 9, see redtop.
Ailanthus, ...27, 59, 64
Alfalfa, ... 4, 7, 10, 12, 16, 36, 44, 58
Algae, ...6, 26, 61
Allium, see garlic, onion.
Alsike clover, ...11, 44, 62
Amaranthus, see pigweed, tumble weed.
Ambrosia, see ragweed, great ragweed.
Aminita, ...61
Anagallis, see pimpernel.
Andropogon, see broomsedge.
Angelica, ...37
Angle-pod 31
Annual blue grass,.............31, 58
Antennaria, see everlasting.
Anthemis, see dog fennel, chamomile.
Anthoxanthum, see sweet vernal grass.
Apium, see celery.
Aplectrum, ...4
Apocynum, see Indian hemp.
Apple, ...3, 14, 16, 17, 62
Arbutus, ...41, 63
Arctium, see burdock.
Arenaria, ...58
Argostemma, see cockle.
Arisaema, see Indian Turnip.
Aristida, see poverty grass.
Aroids, ...41, 61
Artemisia, see wormwood.
Artichoke, ...34, 39, 59
Asclepias, see milkweed, butterflyweed.
Ascyrum, see St. Peter's wort.
Asparagus.........14, 34, 40, 59, 64
Aster, ...14, 39, 57, 59
Atropa, see belladonna.
Avena, see oats.
Azalea.............................63
Bachelor's button, ...58
Bacteria, ...2, 61
Ball mustard, ...39, 58
Balsam, ...64
Baneberry, ...62
Baptisia, see indigo.
Barbarea, see winter cress.
Barley, wild, ...31, 58
Barnyard grass, ...5, 31, 58
Basil, basil thyme, ...34, 59
Bean, ...12, 62
Bedstraw, ...13, 33, 59
Beet, ...12
Beggar's lice, ...41, 59
Beggar tick, ...35, 36, 48
Begonia, ...4, 12
Belladonna, ...63
Bermuda grass, ...5, 7, 28, 42, 49
Beta, see beet.
Bidens, see sticktight, Spanish needle.
Bindweed, 3, 13, 31, 32, 42, 46, 50, 52, 53, 64.
Bittersweet, ...27, 32, 63, 64
Blackberry, ...14, 27, 45, 59
Black bindweed, ...42, 50
Black-eyed Susan, ...39, 48
Black locust, see locust.
Black medick, ...4, 13, 21, 36, 37, 56
Black mustard, ...13, 21, 39, 50
Black nightshade,....3, 40, 41, 58, 63
Bladder campion, ...33
Bloodroot, ...64
Blueberry, ...63
Blue bottle, ...58
Blue curls, ...33, 58
Blue flag, ...64
Blue grass,....9, 12, 19, 29, 31, 43, 58
Bluet, ...33, 59
Blue weed, ...41, 53, 64
Bouncing Bet, ...33, 56
Box, ...27, 62
Bracted plantain, ...22, 40, 58
Brake, ...37, 59
Brassica, see mustard, cabbage, charlock, etc.
Briars, ...13, 45
Broadbean, ...4
Bromus, see cheat.
Broom, ...27, 59, 62
Broom-rape, ...32, 58
Broom sedge, ...31, 56
Broussonetia, see paper mulberry.
Buckeye, ...27, 64
Buckthorn, ...64
Buckwheat, ...2, 9, 34, 59, 64
Buffalo bur, ...32
Bugle weed, ...34, 58
Bulbs, ...64
Bull thistle, ...47, 55
Burdock, ...13, 32, 39, 46, 64
Burnet, ...37, 59
Burning bush, ...27, 64
Bush clover, ...35, 36, 59
Butter and eggs, 13, 23, 28, 40, 53, 63
Buttercup, ...8, 20, 13, 37, 50, 62
Butterfly-weed 41, 64
Buttonbush, ...64
Buttonweed, ...13, 14, 33, 53
Buxus, see box.
Cabbage, ...12, 31, 39
Calamint, ...34

Calla, ...61
Camelina, see false flax.
Campion, ...33, 56
Canada blue grass, ...19, 28, 59
Canada thistle, 5, 8, 9, 13, 24, 47, 54, 55.
Canary grass, ...31
Cannabis, see hemp.
Caper spurge, ...31
Capsella, see shepherd's purse.
Capsicum, see pepper.
Carex, see sedge.
Carpet weed, ...33, 58
Carrot, 4, 7, 10, 12, 13, 14, 22, 35, 43, 63.
Carum, see parsley.
Cassia, see senna, partridge pea.
Castanea, see chestnut.
Castor bean, ...37, 62
Catchfly, ...33, 59
Catnip, ...34, 48
Cattail, ...28, 58
Cedar, ...3, 27, 64
Celandine, ...31, 59, 64
Celastrus, see bittersweet, ...64
Celery, ...12, 63
Cenchrus, see sandbur.
Centaurea, see corn-flower.
Cephalanthus, see buttonbush.
Cerastium, see mouse-ear chickweed.
Chamomile, ...13, 35, 39, 57
Charlock, ...13, 38, 39, 50
Cheat, ...31, 49
Chelidonium, see celandine.
Cherry, ...3, 28, 59, 62
Chess, see cheat.
Chestnut, ...4
Chenopodium, see Mexican tea, lamb's quarters, wormseed, Jerusalem oak, etc.
Chickweed, 10, 13, 14, 15, 20, 26, 33, 44, 52, 56.
Chickweed family, ...56, 58, 59, 62
Chicory, ...13, 23, 32, 53
Choke cherry, ...62
Chondrilla, 54, see skeleton weed.
Chrysanthemum, see oxeye daisy, feverfew.
Chrysopsis, see golden aster.
Cichorium, see chicory.
Cicuta, see water hemlock.
Cinquefoil, ...13, 21, 37, 48, 59
Cirsium, see thistle, Canada thistle.
Clammy weed, ...35, 59
Clematis, ...27, 62
Cleome, see spider flower.
Climbing hempweed, ...32, 58
Clover, clover seed, 3, 4, 9, 10, 11, 12, 14, 17, 26, 32, 35, 36, 43, 44, 45, 53, 56, 57, 58, 59, 62.
Cockle, ...4, 13, 20, 33, 50, 62
Cocklebur, 5, 7, 13, 14, 24, 32, 33, 40, 47, 63.
Cocoanut, ...4
Cocos, ...4
Colocasia, see elephant's ear.
Comfrey, ...41, 59
Commelina, see day flower.
Composite family, ...31, 40
Conium, see hemlock.
Conringia, see hare's ear mustard.
Convallaria, see lily-of-the-valley.
Convolvulus, 13, see bindweed.
Corn, ...4, 7, 12
Corn chamomile, ...13, 35, 39, 57
Corn-flower, ...39, 57, 58
Cornus, see dogwood.
Coronilla, see crown vetch.
Corydalis, ...35, 58
Cotton, ...62
Couch grass, 5, 7, 8, 13, 16, 19, 28, 30, 49.
Cowherb, ...33, 59
Cowpea, ...4, 9, 12, 14, 49
Cow wheat, ...63
Crab grass, 2, 4, 7, 13, 14, 19, 30, 31, 42, 43.
Cranesbill, ...33, 37, 58
Crataegus, see hawthorn.
Cress, ...8, 13, 21, 37, 38, 39, 45
Crimson clover, ...4, 9, 12, 58
Crotalaria, see rattle-box.
Crowfoot, ...37, 59
Crownbeard, ...34, 59
Crown vetch, ...35, 59
Cucumber, Cucumis, 12, see melon.
Culver's root, ...32, 63
Cuphea, see waxweed.
Curled mustard, ...39
Cuscuta, see dodder.
Cut grass, ...28, 58
Cyclamen, ...63
Cynodon, see Bermuda grass.
Cynoglossum, see hound's tongue.
Cyperus, see nut grass, sedge.
Cytisus, see broom.
Dactylis, see orchard grass.
Daisy, 31, see oxeye, blackeyed Susan, chamomile.
Daisy fleabane, see whitetop.
Dandelion, ...5, 13, 14, 24, 31, 48
Danthonia, see wild oat grass.
Daphne, ...64
Darnel, ...31, 59
Datura, 63, see jimson.
Daucus, see carrot.
Day-flower, ...14, 28, 42, 49
Day lily, ...28, 58
Deadly nightshade, ...63
Dead nettle, ...13, 34, 56
Delphinium, see larkspur.
Deptford pink, ...33, 59
Desmodium, see beggar-tick.

Deutzia, ...64
Dewberry, ...27, 45
Dianthera, see water willow.
Dianthus, see Deptford pink.
Digitalis, see foxglove.
Digitaria, see crab grass.
Diodia, see button-weed.
Diospyrus, see persimmon.
Dipsacus, see teasel.
Dirca, see leather wood.
Dock, ...5, 8, 13, 20, 34, 40, 46
Dodder, ...5, 23, 32, 53
Dog fennel, ...13, 35, 54, 64
Dogwood 64
Draba, see whitlow grass.
Duchesnea, see Indian strawberry.
Dwarf dandelion, ...32, 58
Echinochloa, see barnyard grass.
Echium, see blue weed.
Eclipta, ...33, 58
Eel grass, ...28, 58
Egg plant, ...63
Elatine, ...41, 59
Elder, ...27, 58, 64
Elecampane, ...39, 59
Elephant's ear, ...41, 61
Elephant's foot, Elephantopus, 39, 59
Eleusine, see yard grass.
Elm, ...28, 59
Equisetum, see horsetail.
Epigaea, see arbutus.
Epilobium, see willow herb.
Erechtites, see fireweed.
Eragrostis, see stink grass.
Ergot, ...55, 60, 61
Erigeron, 63, see white-top horseweed.
Erodeum, see storksbill.
Eupatorium, 34, 59, see also Joe Pye, thoroughwort.
Euphorbia, see spurge, milk pursley, snow-on-the-mountain.
Evening primrose, ...38, 40, 41, 56, 59
Everlasting, ...14, 39, 59
Evonymus, ...27, 63
Fagopyrum, see buckwheat.
False flax, ...39, 58
Fennel, ...35, 59
Fern, ...37, 38, 58, 64
Fescue, Festuca, ...4
Feverfew, ...37, 39, 59
Field bindweed, ...53
Field madder, ...33, 59
Field peppergrass, ...38, 50
Field poppy, ...57
Figwort, ...34, 59, 63
Fireweed, 14, 39, 57, see also willow herb.
Flax, ...40, 64
Fleabane, see whitetop, horseweed.
Flower-of-an-hour, ...37, 58
Foeniculum, see fennel.
Forsythia, ...27, 63
Foxglove, ...40, 63
Foxtail, ...4, 5, 13, 14, 19, 31, 46
Fragaria, see strawberry.
French pink, ...58
Frost weed, ...57
Fumara, fumatory, ...31, 59, 64
Fungi, ...2, 3, 26, 55, 61
Galinsoga, ...34, 54
Galium, see bedstraw.
Garlic, ...8, 28, 43
Garlic mustard, ...39
Gaura, ...40, 59
Geranium, 37, see cranesbill.
Gerardia, ...33, 59, 63
Gifola, see everlasting.
Gillenia, see Indian physic.
Glaucium, see sea poppy.
Glycine, see soy bean.
Gnaphalium, see everlasting.
Goat's rue, ...35, 36, 62
Golden aster, ...39, 59
Golden rod, ...28, 39, 47, 64
Gonolobus, see angle-pod.
Goosefoot, ...40
Gossypium, see cotton.
Grape, ...12
Grape hyacinth, ...28, 50
Grains, ...7, 12, 49, 50, 58
Grasses and grass seed, 3, 8, 10, 12, 14, 17, 44, 45, 48, 50, 55, 56, 58, 59, 61.
Great ragweed, 4, 5, 13, 14, 33, 37, 48
Grindelia, see gum plant.
Gromwell, ...40, 58
Ground cherry, ...3, 40, 41, 56, 63
Ground ivy, ...13, 34, 56, 64
Groundsel, ...39, 59
Gum plant, ...39, 59
Gymnocladus, see Kentucky coffee-tree.
Hare's-ear mustard, ...39, 58
Hawkweed, ...31
Hawthorn, ...27
Heal-all, ...23, 34, 59
Heath family, ...63
Hedeoma, see pennyroyal.
Hedge bindweed, ...42, 53
Hedge mustard, ...39
Hedge nettle, ...34, 59
Helenium, see sneezeweed.
Helianthus, see artichoke, sunflower.
Hellebore, ...40, 61
Heliotrope, ...64
Hemerocallis, see day lily.
Hemlock, ...4, 35, 37, 60, 63
Hemp, ...64
Hemp-weed, ...32, 59
Henbane, ...63
Henbit, see dead nettle.
Hesperis, see rocket.
Heterotheca, ...39, 59
Hibiscus, see flower-of-an-hour.

Hieracium, see hawk-weed, rattle-snake-weed.
Holly, 27, 64
Honeysuckle, 13, 14, 27, 47, 64
Hop clover, 36, 37, 59
Hordeum, see wild barley, squirrel-tail grass.
Horehound, 34, 59
Horn poppy, 59
Horse-chestnut, 27, 64
Horse mint, 34, 59
Horse nettle, 3, 5, 8, 10, 13, 14, 32, 38, 46, 63.
Horseradish, 12, 38, 62
Horsetail, 32, 34, 64
Horse-weed, 13, 39, 42, 48, 63
Hound's tongue, 41, 59
Houstonia, see bluet.
Hungarian grass, 46, 64
Hydrangia, 64
Hyoscyamus, see henbane.
Hypericum, see St. John's-wort, orange grass.
Ilex, see holly.
Impatiens, 58, 64, see touch-me-not, balsam.
Indian hemp, 31, 51, 64
Indian mustard, 39
Indian physic, 37, 64
Indian strawberry, 37, 59
Indian tobacco, 63
Indian turnip, 35, 61
Indigo, 35, 36, 59, 62
Insects, 3, 13, 59
Inula, see elecampane.
Ipomoea, see morning glory, sweet potato.
Ironweed, 39, 48
Japan clover, 4, 35, 36, 59
Japanese honeysuckle, 13, 14, 27, 47, 64.
Japanese knot-weed, 34, 59
Japanese quince, 16
Jerusalem artichoke, 34, 39, 59
Jerusalem oak, 40
Jimson, 4, 13, 32, 37, 40, 47, 60, 63
Joe Pye weed, 32, 58
Johnson grass, 4, 28, 57, 59
Juglans, see walnut.
Juncus, see rush.
Juniperus, see cedar.
Kale, 12, 39
Kalmia, see laurel.
Kentucky coffee-tree, 28, 62
Knawel, 33, 58
Knotweed, 34, 59, see Polygonum.
Kochia, 40, 59
Krigia, see dwarf dandelion.
Lactuca, see lettuce, wild lettuce.
Lady's thumb, 43
Lambkill, 63
Lamb's quarters, 4, 5, 13, 14, 20, 30, 40, 45.
Lamium, see dead nettle.
Laportea, see stinging nettle.
Lappula, see beggar's lice.
Larkspur, 35, 37, 62
Laurel, 28, 63
Leather wood, 64
Lechea, see pinweed.
Leersia, see cut grass.
Legumes, 9, 35, 36, 62
Leonurus, see motherwort.
Lepidium, see peppergrass.
Lespedeza, see bush clover, Japan clover.
Lettuce, 5
Lichen, 13, 26
Ligustrum, see privet.
Lily-of-the-valley, 40, 61
Lily family, 64
Lima bean, 4, 62
Linaria, see butter and eggs, toad flax.
Lithospermum, see gromwell.
Live-for-ever, 40, 59
Lobelia, 31, 63, see Indian tobacco.
Loco, 61
Locust, 16, 17, 26, 27, 59, 62
Lolium, see rye grass, darnel.
Lonicera, see honeysuckle.
Lousewort, 33, 63
Lupine, Lupinus, 4, 35, 36, 59, 62
Lycium, see matrimony vine.
Lychnis, see white campion.
Lycopersicum, see tomato.
Lycopus, see bugleweed.
Lyonia, see stagger bush.
Lysimachia, see moneywort.
Maclura, see Osage orange.
Maidenhair fern, 64
Mallow, 4, 13, 14, 40, 50
Malva, see mallow.
Marjoram, 34
Marrubium, see horehound.
Marsh cress, 37, 39
Matricaria, see wild chamomile.
Matrimony vine, 28, 63
May apple, 37, 62
May-weed, see dog fennel.
Meadow beauty, 33, 59
Meadow rue, 37
Medicago, medick, see alfalfa, black medick.
Melampyrum, see cow wheat.
Melilotus, see sweet clover.
Melon, 12
Menispermum, see moonseed.
Mentha, see mint.
Mercury, 40, 58
Mexican tea, 40
Mikania, see hemp-weed.
Mildew, 26
Milk pursley, 58

Milkweed, 14, 31, 47, 51, 60, 62, 64, see also spurge, Indian hemp.
Millet, ...4, 9, 12, 46, 64
Mimulus, see monkey flower.
Mint, ...34, 58
Mint family, ...34, 64
Mold, ...26, 61
Mollugo, see carpet weed.
Monarda, see horse mint, wild bergamot.
Moneywort, ...33, 53
Monkey flower, ...34, 58
Moonseed, ...64
Morning glory, 3, 4, 5, 13, 14, 31, 32, 42, 46, 64. See also bindweed.
Moss, ...13, 26, 55
Motherwort, ...32, 33, 59
Moth mullein, ...4, 23, 56
Mountain ash, ...27, 64
Mountain mint, ...33, 34, 59
Mouse-ear chickweed, ...13, 33, 56
Mouse-ear cress, ...39, 58
Muhlenbergia, see nimble Will.
Mullein, ...4, 14, 23, 40, 56, 63
Muscaria, see grape hyacinth.
Mushroom, ...26, 61
Mustard, 3, 5, 10, 12, 13, 21, 31, 38, 39, 40, 50, 57, 62.
Mustard family, 3, 12, 31, 35, 37, 38, 39, 40, 59, 62.
Nepeta, see catnip, ground ivy.
Nerium, see oleander.
Neslia, see ball mustard.
Nicotiana, 41, 63, see tobacco.
Night flowering catchfly, ...33
Nightshade, ...3, 40, 41, 58, 63
Nimble Will, ...13, 28, 30, 49
Nut grass, ...5, 28, 49
Oak, ...4
Oat grass, ...31, 59
Oats, ...9, 29, 43, 49
Oenothera, see evening primrose.
Oleander, ...27, 63
Onion, ...12
Onobrychus, see sanfoin.
Onoclea, see fern.
Opuntia, see prickly pear.
Orange grass, ...59
Orchard grass, ...9, 12, 14
Origanum, see wild marjoram.
Orinthogalum, see star of Bethlehem.
Orobanche, see broom-rape.
Osage orange, ...27, 59, 64
Osmunda, see fern.
Oxalis, 13, 14, 35, 59, 64, see wood-sorrel.
Oxeye daisy, 8, 10, 13, 14, 24, 39, 44
Ox-tongue, ...32, 58
Oyster plant, ...12
Panic grass, Panicum, ...31, 55
Papaver, see poppy.
Paper mulberry, ...28, 59
Parsley, ...12, 63
Parsnip, ...12, 37, 63
Partridge pea, ...35, 36, 58
Paspalum, ...13, 14, 31, 55
Pastinaca, see parsnip.
Pea, ...12
Peach, ...16, 17, 62
Pearlwort, ...33, 58
Pedicularis, see lousewort.
Penny cress, ...39
Pennyroyal, ...34, 59
Pepper, ...12, 63
Peppergrass, ...13, 21, 38, 39, 50, 58
Peppermint, ...34, 58
Persimmon, ...28, 59
Petunia, ...41
Phalaris, see Canary grass.
Phaseolus, see bean, Lima bean, scarlet runner.
Philadelphus, ...64
Phleum, see timothy.
Physalis, see ground cherry.
Phytolacca, see poke.
Picris, see ox-tongue.
Pigweed, 4, 5, 7, 13, 14, 20, 32, 41, 44, 50.
Pimpernel, ...33 63
Pine, Pinus, ...27, 59
Pink, pink family, 26, 33, 58, 59, 62
Pinweed, ...40, 59
Pisum, see pea.
Plantago, 59, see plantain, ripple.
Plantain, 3, 5, 10, 13, 14, 15, 22, 40, 44, 57, 59.
Plum, ...3, 27, 28, 59
Poa, see blue grass.
Podophyllum, see May apple.
Poison hemlock, ...35, 37, 63
Poison ivy, ...13, 14, 27, 62
Poison oak, ...27, 62
Poison sumach, ...28, 62
Poke, ...41, 61
Polanisia, see clammy weed.
Polygonum, see black bindweed, knotweed, lady's thumb, prince's feather, smartweed, tear-thumb, yardweed.
Polypremum, ...33
Pondweed, ...28, 58
Poplar, ...28, 59
Poppy, ...13, 31, 57, 64
Populus, see poplar.
Portulaca, see pursley.
Potamogeton, see pondweed.
Potato, ...3, 7, 12, 14, 63
Potentilla, see cinquefoil.
Poverty grass, ...31, 59
Prickly lettuce, ...32, 54
Prickly pear, ...32
Primrose, Primula, ...37, 40 63
Prince's feather, ...34, 59
Privet, ...27, 63
Prunella, see heal-all.

Prunus, see cherry, plum, peach, wild cherry.
Psedera, see Virginia creeper.
Pteris, see brake.
Pursley, purslane, 2, 7, 8, 13, 33, 40, 46.
Pycnanthemum, see mountain mint.
Pyrus, see apple, Japanese quince, mountain ash.
Quack grass, see couch grass.
Quercus, see oak.
Rabbit-foot clover, ...50
Radicula, see yellow cress, water cress, horseradish.
Radish, ...12, 39
Ragged sailor, ...58
Ragweed, 4, 10, 13, 14, 23, 33, 35, 37, 43, 48.
Ranunculus, see buttercup, crowfoot.
Rape, ...39
Raphanus, see radish, wild radish.
Raspberry, ...27, 45, 59
Rattlebox, ...36, 41, 62
Rattlesnake-weed, ...31, 59
Red cedar, ...3, 27, 64
Red clover, ...4, 11, 12, 14
Red pepper, ...63
Redtop, ...11
Rhamnus, see buck-thorn.
Rhexia, see meadow beauty.
Rhinanthus, see yellow rattle.
Rhododendron, ...28, 63
Rhus, see poison ivy, sumach.
Richardia, see calla.
Ricinus, see castor bean.
Ripple, 2, 5, 9, 10, 13, 14, 15, 22, 40, 45.
Robinia, see locust.
Rocket, ...39
Rubus, 27. See briars, blackberry, dewberry, raspberry and wineberry.
Rudbeckia, see black-eyed Susan.
Rue, ...64
Rumex, see dock, sorrel.
Rush, ...5, 29, 59
Rust, ...26, 45, 59, 61
Ruta, see rue.
Rutabaga, ...39
Rye, ...2, 9, 29, 49, 59, 61
Rye grass, ...4, 31, 59
Sagina, 59, see pearlwort.
Sanfoin, ...4
St. John's-wort, ...13, 33, 47, 62
St. Peter's-wort, ...33, 59
Salix, see willow.
Sambucus, see elder.
Sandbur, ...5, 29, 32, 49
Sandwort, ...33, 58
Sanguinaria, see bloodroot.
Sanguisorba, see burnet.
Saponaria, see bouncing Bet, cow herb.
Sassafras, ...14, 28, 47, 64
Satureja, see basil, basil-thyme, calamint.
Scarlet runner, ...62
Scleranthus, see knawel.
Scotch broom, ...27, 59, 62
Scrophularia, see figwort.
Scurvy grass, ...45
Sea poppy, ...31, 59
Secale, see rye.
Sedge, ...5, 28, 58
Sedge grass, 56, see broomsedge.
Sedum, see live-for-ever.
Senecio, see groundsel.
Senna, ...35, 36, 59
Sericocarpus, see white-topped aster.
Setaria, see millet, foxtail, Hungarian grass.
Sheep sorrel, see sorrel.
Shepherd's purse, ...4, 13, 39, 47
Sherardia, see field madder.
Sida, ...40, 59
Silene, 55. See catchfly.
Silver poplar, ...28, 59
Sisymbrium, see tumbling mustard, mouse-ear cress, hedge mustard.
Skeleton weed, ...32, 42, 54
Skunk cabbage, ...41, 61
Sleepy catchfly, ...33, 58
Smartweed, ...13, 14, 34, 43, 58, 64
Smilax, ...27
Smut, ...26, 61
Sneezeweed, ...39, 63
Snow-on-the-mountain, ...31, 62
Solanum, see bittersweet, egg plant, buffalo bur, horse nettle, nightshade, potato.
Solidago, see golden rod.
Sonchus, see sow thistle.
Sophora, ...62
Sorghum, 9. See also Johnson grass.
Sorrel, 5, 10, 13, 14, 15, 19, 34, 44, 64
Sow thistle, ...32, 55, 57
Soy bean, ...4
Spanish needle, 5, 13, 14, 32, 33, 35, 37, 45.
Spearmint, ...34, 58
Specularia, see Venus' looking-glass.
Speedwell, ...33, 41, 53, 58
Spergula, 58. See spurry.
Spider flower, ...37, 59
Spinach, Spinacia, ...12
Spiny cocklebur, ...24, 32, 54
Spiny pigweed, ...32, 50
Spurge, ...31, 58, 59, 62
Spurry, ...33, 58
Squirrel-tail grass, ...58
Stachys, see hedge nettle.
Stagger bush, ...28, 63
Star of Bethlehem, ...28, 49
Starwort. 33
Steelweed, ...57
Stellaria, see chickweed, starwort.

Sticktight, ...13, 14, 24, 45
Stickweed, ...57
Stinging nettle, ...32, 58, 64
Stink grass, ...31, 58
Storksbill, ...35, 58
Strawberry, 10, 12, 14, 44, 50, 59, 61, 64.
Strophostyles, see wild bean.
Sumach, ...16, 17, 28, 59, 62
Sunflower, ...34, 39, 59
Swamp sumach, ...62
Sweet clover, ...2, 4, 13, 36, 37, 56
Sweet potato, ...14
Sweet vernal grass, ...31, 59
Symphytum, see comfrey.
Symplocarpus, see skunk cabbage.
Tall redtop, ...31, 56
Tanacetum, see tansy.
Tansy, ...35, 59, 64
Taraxacum, see dandelion.
Tare, ...32, 57
Tear-thumb, ...34, 58
Teasel, ...32, 56
Tecoma, see trumpet creeper.
Tephrosia, see goat's rue.
Thalictrum, see meadow rue.
Thistle, ..5, 8, 9, 13, 32, 47, 54, 55, 64
Thlaspi, see penny cress.
Thoroughwort, ...34, 58, 59
Three-seeded mercury, ...13, 40, 58
Thyme, Thymus, ...34
Timothy, ...11, 29, 57
Toadflax, ...40, 59
Toadstool, ...61
Tobacco, ...12, 41, 63
Tomato, ...3, 7, 12, 14, 63
Touch-me-not, ...40, 58, 64
Tragopogon, see oyster plant.
Trailing arbutus, ...41, 63
Tree of heaven, ...27, 59, 64
Trichostema, see blue curls.
Tridens, see tall red top.
Trifolium, see clover.
Triticum, see wheat.
Trumpet creeper, ...27, 53, 64
Tumble weed, ...41
Tumbling mustard, ...13, 39, 42, 57
Turnip, ...12, 31, 39
Typha, see cat-tail.
Ulmus, see elm.
Urtica, 59, see stinging nettle.
Vaccinium, see blueberry.
Vallisneria, see eel grass.
Velvet leaf, ...13, 40, 41, 48, 64
Venus' looking-glass, ...32, 58
Veratrum, see hellebore.
Verbascum, see mullein.
Verbena, see vervain.
Verbesina, see crownbeard.
Vernonia, see iron-weed.
Veronica, see speedwell, Culvers' root.
Vervain, ...4, 22, 34, 59
Vetch, ...4, 32, 57
Vicia, see broad bean, tare, vetch.
Vigna, see cowpea.
Violet, Viola, ...40, 59, 64
Virginia creeper, ...12, 64
Vitis, see grape.
Wahoo, ...27, 64
Walnut, ...64
Wandering Jew, ...14, 49
Water celery, ...58
Water cress, ...37, 39, 45
Water hemlock, ...37, 60, 63
Water scum, ...6, 26, 61
Water willow, ...28, 33, 58
Wax-weed, ...13, 33, 59
Wheat, 4, 7, 29, 43, 44, 49, 50, 53, 57, 59, 61.
White campion, ...33, 56
White clover, ...4, 12, 36
White mullein, see moth mullein.
White mustard, ...39. 50
White-top, 5, 7, 8, 10, 13, 14, 39, 42, 44, 63.
White-topped aster, ...59
Whitlow grass, ...13, 39, 58
Wild barley, ...31, 58
Wild bean, ...32, 35, 36, 58
Wild bergamot, ...34
Wild buckwheat, see black bindweed.
Wild chamomile, ...35
Wild carrot, 4, 7, 10, 13, 14, 22, 35, 43
Wild cherry, ...3, 28, 62
Wild garlic, ...38, 43
Wild geranium, ...37
Wild indigo, ...35, 36, 59, 62
Wild lettuce, ...5, 14, 32, 54, 59, 64
Wild marjoram, ...34
Wild mustard, ...5
Wild oat grass, ...31, 59
Wild onion, see wild garlic.
Wild radish, ...37, 39, 57
Wild rye, ...31
Wild senna, ...35, 36, 59
Willow, ...28, 59
Willow herb, ...41, 59
Wine berry, ...27, 59
Winter cress, 8, 13, 15, 21, 37, 38, 39, 45.
Wiregrass, see Bermuda grass, nimble Will.
Wood sorrel, ...35, 59, 64
Woolly clover, ...35, 36, 50
Wormseed, ...40, 56
Wormwood, ...64
Xanthium, see cocklebur.
Yard grass, ...5, 31, 42, 56
Yard weed, ...5, 13, 23, 34, 59
Yarrow, ...10, 13, 14, 24, 35, 57
Yellow clover, ...36, 37, 59
Yellow cress, ...37, 39, 58
Yellow daisy, see black-eyed Susan.
Yellow oxalis, ...13, 59
Yellow rattle, ...34
Yellow trefoil, ...56
Zea, see corn.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 156. SEPTEMBER 1911.

ROSE MILDEW.

By J. B. S. NORTON and THOS. H. WHITE.

Powdery mildew is one of the most common and injurious diseases of roses, wherever they are grown. In regions where the climate is most suitable for outdoor rose culture, mildew is also prevalent; but here it is rarely troublesome except in the greenhouse, where it often causes serious injury. A few varieties, the Crimson Rambler and some related forms especially, are badly injured outdoors, but much less so when grown away from walls so that they have free air exposure.

The mildew is usually first noticed as grayish or whitish spots on the young leaves or shoots, these being more or less distorted by the disease. Later as the spots enlarge they have a white, powdery appearance, or on the stems, or thorns more than elsewhere, may have a quite felt-like coating. After a few weeks as the affected parts mature, the mildew appearance is lost and the injured portions show a dark color.

The young leaves, stems and buds are dwarfed, curled or variously deformed by the disease. The foliage is reduced by the deformation and killing of parts of the leaf surface, and by the dropping of the injured leaves, and growth and flower production is seriously interfered with. The young buds themselves are often attacked by the mildew, the flower clusters of the Ramblers sometimes being completely covered by it and entirely worthless.

CAUSE OF MILDEW.

If one of the very young mildew spots which can just be distinguished is examined with a microscope which magnifies 10 or 20 diameters, one can easily see that the spot consists of a mold-like growth such as is shown in Figure 1. This fungus * is composed of slender, white threads with numerous branches, running out from the center of the spot and forming a net-work over the surface of the rose leaf. At various points these threads produce a different kind of branches, which are erect and bear on their ends chains of minute egg-shaped bodies (spores) which are easily detached and in older spots lie in masses on the surface and give it a powdery appearance.

Figure 2 shows a cluster of spore-bearing branches greatly enlarged. Figure 3 shows one very highly magnified, indicating the internal appearance of the spores,—a mature one detached at *a*. Figure 5 shows thickly felted mildew on a Crimson Rambler thorn (x50) with less dense growth of spores on the younger portion at the left.

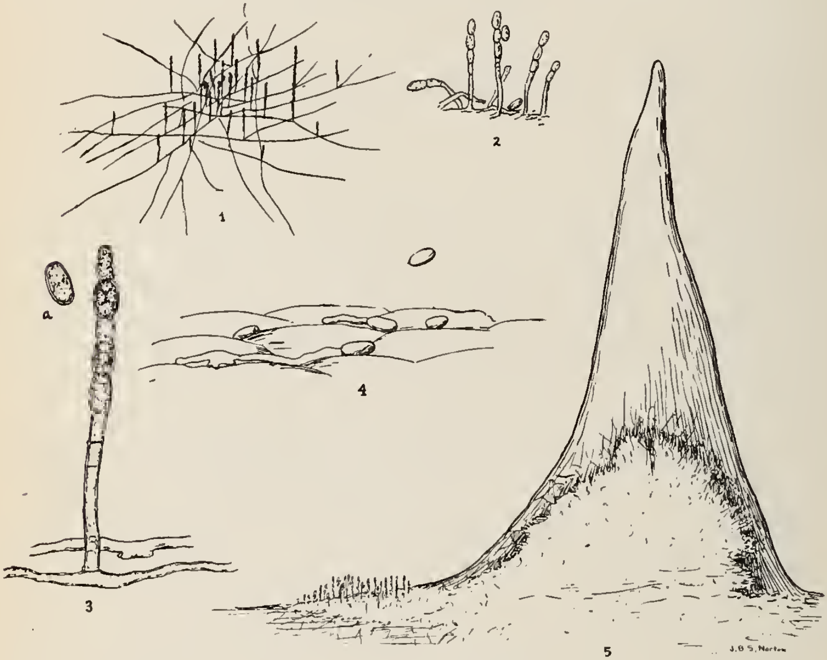


Fig. 1-5.—The mildew fungus.

(*) There are two powdery mildew fungi occurring on roses, *Sphaerotheca pannosa* (Wallr.) Lev. and *S. humuli* (D C.) Burr. In Salmon's monograph (Mem. Torr. Bot. Club 9. 1900) he states that practically all the American rose mildews which he had seen were *S. humuli*. Almost all American authors, however, both before and since that time, consider our rose mildew to be *S. pannosa*. The two are hardly to be separated in the conidial stage, and perithecia are rarely found on rose mildews and then only out doors. From all reports it seems certain that *S. pannosa* is common here, but published data, especially from Europe, with regard to *S. pannosa* should be considered with caution when applied to American greenhouse mildews on roses. For a recent discussion of this question see Stewart, N. Y. Exp't Sta. Bull. 328: 390. 1910.

The spores drop from their stalks when mature and are blown about freely by the slightest air currents. By touching a mildewed shoot in the light with a dark background, one can easily see a shower of the fine, dust-like spores. They germinate readily, and a careful examination of a young leaf that has been exposed to them, with a microscope of high magnifying power, will show them in various stages of growth as indicated in Figure 4 (diagramatic). The little thread which comes from the germinating spore grows quickly, branches and in a few days is producing a new crop of spores.

At various points, later indicated by brown or black specks on the mildewed spots, the threads are attached to the rose surface and even send minute branches into the outer cells of leaf or stem and draw their nutriment from them. In this way most of the damage is done, though the presence of the felted mass of mildew may also interfere with the action of light upon the leaves and the passage of gases into and out of them. The cells which are being drawn upon by the mildew fungus appear to be first stimulated to a slightly more vigorous growth, as indicated by the attacked spots being raised on the mildewed side while the opposite side of the leaf shows a depression, but they soon die from the injury.

While it is easy to see that certain climatic conditions favor the occurrence of mildew, just as certain conditions are necessary for the proper development of roses, careful work by many students of fungi has shown that unless the fungus is present there will be no mildew, no matter what the climatic conditions, just as there could be no roses, however favorable the air and soil, unless there are cuttings or seeds to start from.

A single spore will produce thousands of new ones in a week, more or less, and each of these, so easily carried through the air, is capable of making a new mildew spot if it gets a chance to grow on young rose tissue. Thus the mildew can spread with great rapidity.

These spores probably do not live a long time and are easily killed, but other means are provided for carrying the fungus over long periods unfavorable to the growth of mildew. Rarely, and chiefly out doors, another form of spore, able to live over winter is produced in little spore-cases which appear as minute, dark specks embedded in the felt-like mildew on stems, thorns, etc. It is probable also that the mildew threads themselves live over winter out doors in the winter buds of roses. Laubert * mentions certain new shoots of rose being covered with mildew from the first in spring, while others were entirely free from it. The same condition is frequent with apple mildew in Maryland.

There is a great difference in susceptibility of varieties. In addition to the Ramblers already mentioned, Ellwanger † says that the varieties of Giant of Battles type are very subject to mildew;

(*) Laubert and Schwartz, Rosenkrankheiten und Rosenfeinde. 1910.

(†) Ellwanger, The rose. 1898.

and according to Foster-Melliar* varieties with soft, spongy leaves are first attacked, while hard, shiny, well glazed leaves such as the teas, do not suffer so much except in greenhouses. Powdery mildew of peach, almond, apricot and cherry laurel is considered to be caused by the same species of fungus as the rose mildew.

EXPERIMENTS.

The experiments conducted may be considered under three heads:
(1) The relation of drafts to mildew.
(2) Controlling by burning sulfur.
(3) Controlling by vaporizing sulfur.

THE RELATION OF DRAFTS TO MILDEW.

Many florists believe that rose mildew is caused by drafts. There are good reasons for this theory, for it has been noticed many times that roses get badly mildewed when exposed to a draft. Mildew will be noticed first in that part of a house subject to a light draft, it may be only from an open door or a broken pane of glass. Growers recognize this, hence very minute directions for the control of the ventilation are given by writers on rose growing.

When the new greenhouses were erected at this Experiment Station in the summer of 1908, one house, 20x50, was prepared with a partition running across the center. This divided the house into two sections. Top ventilation was arranged as usual on both sections. The north section in addition to this was provided with narrow ventilators close to the ground, so that cold air would enter beneath the benches. The idea was that air could be admitted this way and the temperature modified without any drafts on the plants. Of course it was recognized that the heated air could not pass off as readily as it would at the apex of the roof but for the purpose of the experiment would give comparative results.

The roses were planted and cared for in the usual way. The ventilation, however, was given through the summer months by opening the top ventilators in both sections. After the weather began to get cool in September the top ventilators in the north section were kept entirely closed and only the low-down, side ventilators were used. These worked very satisfactorily except that it was found necessary to hang a cloth curtain in front of the opening, so that the incoming air was admitted about six inches from the floor. The other or south section was ventilated always from the top. No other means were taken for the prevention of mildew. Early in October the fungus was noticed in the section ventilated at the top. This spread very rapidly until there was considerable infection. Later, small patches were noticed in the section that was ventilated only from below. As this appeared in direct line of the door connecting the two sections it was concluded that the infection came through the door in the

---

(*) Foster-Melliar, The book of the rose. 1902.

draft from the other section. After infection the fungus continued to spread and in order to save the crop of roses, sulfur was painted on the pipes. The following season the experiment was tried again and careful attention was paid to the closing of the partition door. Mildew again appeared in the top ventilated section early in the winter. It was late in February, however, before any showed in the north section. This time it appeared in the northeast corner and was noticed after several days of a prevailing wind in that direction. Sulfur was again used to control the infection.

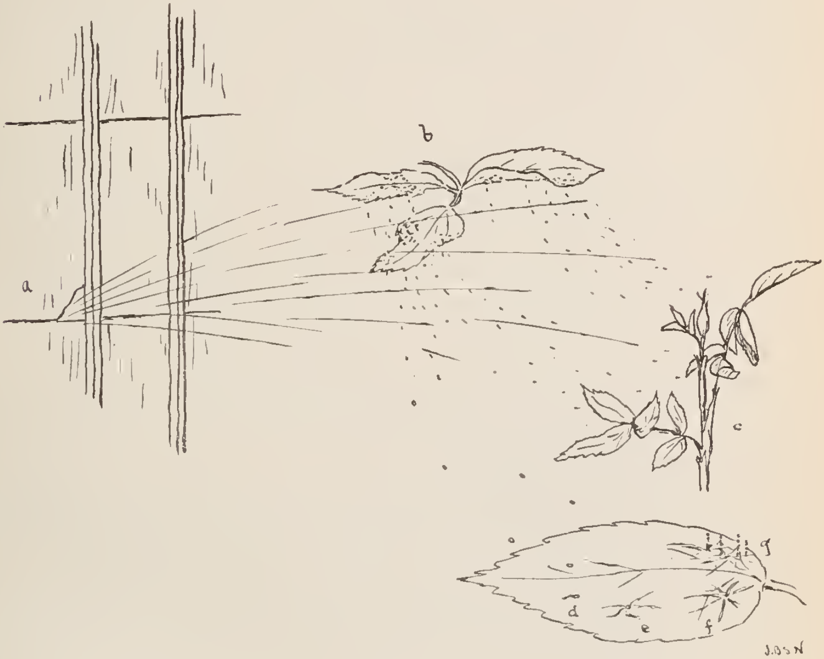


Fig. 6.—Diagram showing how mildew spreads.

In the meantime in order to test the atmospheric conditions and their relation to mildew, some small plants were inoculated with the spores and placed under different conditions as follows: One was placed under a bell-jar in the rose-house where the air conditions would be very warm and moist. Another was left free on the bench beside the bell-jar and another carried into a room where the temperature was low and the air dry. Other plants, uninoculated, were used as checks, one under a bell-jar and one outside. Those on the bench were exposed to a slight draft from a broken glass nearby. On the sixth day mildew appeared on all the inoculated plants. On the plant in the humid conditions of the bell-jar it only developed on the very softest leaves. This was practically the same with the one left on the bench. The plant in the cool, dry room was infected on all the younger leaves. None of the uninoculated plants showed any signs of mildew. Another potted plant badly affected with mildew was placed beneath a bell-jar in which the temperature, as shown by a thermometer, ran up as high as 130 degrees F. and came out in a few days with the mildew apparently all killed.

Figure 6 is a diagram showing how mildew may be disseminated by drafts. The air currents from the broken glass at *a* are shown carrying the spores which fall from the mildewed leaf at *b* to the young rose shoot at *c*. The leaf below shows various stages of mildew (*d, e, f, g*), from the spores falling on the leaf and germinating at *d* to the production of spore chains again at *g*, all greatly enlarged in proportion to the leaf on which they appear.

CONTROLLING BY BURNING SULFUR.

The two devices used for this purpose were obtained from men advertising in the florists trade papers. The first one tried was a copper shell, cylindrical in shape, and perforated all around. It was supplied with two small doors and a handle or bale to carry it with. There was an upper and a lower section. In the upper section was a cast iron pan holding about two tablespoonfuls of sulfur. In the lower was an alcohol lamp.

The directions were to light the alcohol lamp and melt the sulfur, after which the melted sulfur was set on fire with a match. The apparatus was then to be carried through the house and be swung from side to side. This was to be kept up until the odor of the sulfurous gases could be detected.

The other device seemed to be a home made affair, having the same idea of burning sulfur. But instead of the alcohol lamp, this apparatus used sulfur candles. These candles consisted of about two ounces of sulfur tied up in a small piece of cheese cloth. This was evidently dipped into and coated with paraffin. The sulfur was burned by setting fire to the cheese cloth, which was kept burning by the coating of wax. These devices were tried several times and the vapor made quite strong but the mildew was not killed. One time the gases were so strong that various tender weeds on the benches were severely injured. The roses, however, and the mildew were not affected. Since that time, while using an apparatus for boiling sulfur, the sulfur caught fire and before it was noticed had filled the house with the blue vapor. The ventilators were opened at once, but serious damage had resulted, several plants loosing their foliage entirely. This was a much larger dose than the manufacturers of these devices recommended, yet the mildew did not seem to be killed.

CONTROLLING BY VAPORIZING SULFUR *.

The apparatus used for this work is called the Campbell vaporizer. In this the sulfur boils over an alcohol lamp but does not burn. This is very effective and safe if the directions are closely followed. The principal feature of this device is the pot in which the boiling takes place. There being only a small opening in the top of this vessel it is almost impossible for the sulfur to get on fire. It must be watched, however, for it will sometimes, if quite full, boil over. The vapors given off in this apparatus are entirely different to those in which the sulfur is burned. Soon after the lamp is lighted a rather heavy, yellow vapor rises from the mouth of the pot. This seems to be composed of very fine particles of sulfur. After a few moments this vapor begins to settle down all over everything in the house. Thus all the foliage is covered with a fine layer of sulfur. The effect on the mildew does not seem to be immediate, but after a few days the grayish looking fungus disappears and nothing but the black scars are left.

The common method of painting the heating pipes with a mixture of sulfur and a small amount of lime has a similar effect on the mildew, but a much less dense vapor is seen †.

OBSERVATIONS AND CONCLUSIONS.

1. Mildew, if allowed to get a hold, soon spreads over the entire house, unless conditions are against it. One of the conditions favorable to the spread of mildew is dry, cool air, such as would come into a greenhouse from ventilation, broken glass or open doors. Under such conditions the plants are to a certain extent wilted. The same air conditions favor the spread of the spores. A close and moist condition of the atmosphere is not favorable to the spread of mildew but may make the plants very soft and succulent and the youngest and most succulent portions of the plant are most readily affected by the disease.

2. The low-down side method of ventilation, while it retards the appearance of mildew, would not be practicable in a range of houses.

3. The mildew should be controlled when the attack is comparatively slight. If mildew shows, no time should be lost in vaporizing sulfur to kill off the spores. As the fungus developes from the spore and matures a new crop of spores in six or eight days it only

---

(*) Maynard of Massachusetts reported in 1889 (Hatch Exp. Sta. Bulletin 4) the successful use of volatilized sulfur for the control of rose mildew, black spot and even red spider. He used a handstove on which the sulfur was kept heated to near the boiling point in a thin iron kettle for 3 or 4 hours, 2 to 3 times a week, or enough to give a visible vapor in the house, taking every precaution to prevent burning the sulfur. A somewhat similar method is used by some Maryland rose growers. There is much danger of the sulfur taking fire in the open kettle and ruining the whole house.

(†) According to Kreamer (Proc. Am. Phil. Soc. 45: 157. 1906; Science 23: 941. 1906), the gas slowly given off from the pipes is sulfuric acid.

takes a short to infect the entire house. During the winter when firing is going on and the pipes are hot, painting them with sulfur will usually keep down mildew. At other times a sulfur vaporizing appliance will be found very useful. The appliances for burning sulfur are useless to control the trouble and the chance for injury is very great.

Outside rose mildew can be controlled by spraying with concentrated lime-sulfur solution, 1 to 50 of water, or any good fungicide, applied frequently.

5. A very heavy vapor from boiled sulphur does not injure the foliage but did injure outer petals of half blown roses.

6. The over dose of burning sulphur killed the leaves badly but did not seem to injure the petals of half open buds.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 157, OCTOBER, 1911.

INCREASING THE EGG PRODUCTION.

By C. L. Opperman.

Introduction.

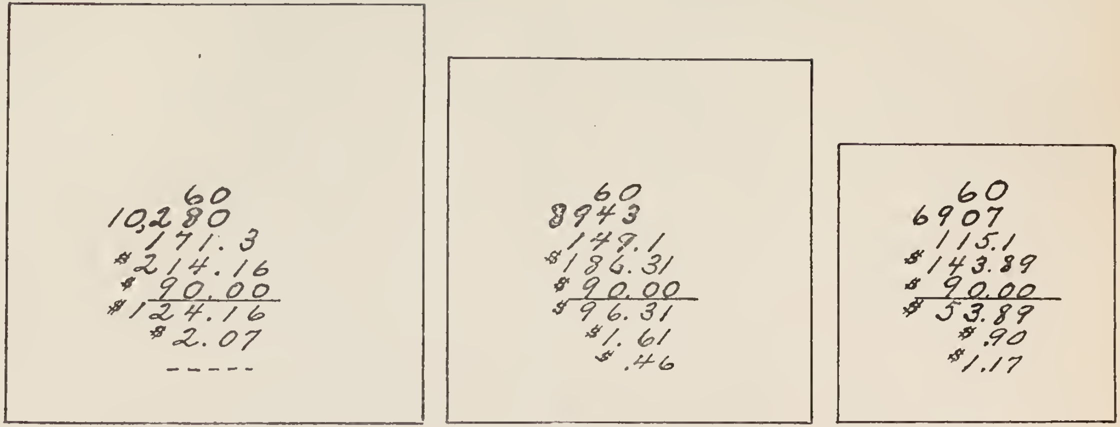
That the average egg yield in Maryland is entirely too low goes without saying. In the last census the Maryland hen is credited with an average of 70 eggs per year. The main reasons for this low production are namely: improper housing, injudicious feeding, lack of knowledge concerning the principles of breeding and the retention of fowls after they have passed their second year. Of these four, injudicious feeding and the retention of the old birds are the most important. There is an abundance of good, practical, free literature on the subject of housing, breeding and feeding, published by the U. S. Department of Agriculture and the various Agricultural Colleges and Experiment Stations. This may be procured by mailing a card to the Experiment Stations, or to the Secretary of Agriculture, Washington, D. C. It is the purpose of this bulletin to discuss in a purely practical manner some reasons for the elimination of the last named cause.

120 eggs
What the Maryland hen should be doing.

70 eggs
What she is doing.
Photo by Waite.

Age and Its Relation to Egg Production.

In plate I, figures I, II and III, is shown a geometrical illustration of the egg production of 60 fowls during the first, second and third years. The high average per hen, made during the pullet year, is due to the fact that the birds were selected for this experiment after they had completed their pullet year record. They had, however, at no time been bred for egg production, but were selected from a flock of 240 White Leghorns which were hatched from eggs procured from a farmer in the State. The object in selecting good performers was to determine if possible whether such birds would show a marked decrease in egg yield after the first and second years.



	Figuree I.	Figure II.	Figure III.
No. hens	60	60	60
Total egg production	10,280	8943	6907
Average per hen	171.3	149.1	115.1
Total income	$214.16	$186.31	$143.89
Feed and expenses	$90.00	$90.00	$90.00
Profit	$124.16	$96.31	$53.89
Profit per hen	$2.07	$1.61	$.90
Decrease per year in profit.	-----	$.46	$1.17

Figuree I. Figure II. Figure III.

Plate I.—Geometrical illustration of succeeding yearly egg production.

Figure I, first year. Figure II, second year. Figure III, third year.

C. L. O.

During the pullet year the fowls produced 10,280 eggs or an average of 171.3 eggs per hen. The market value of these eggs at an average price of 25 cents per dozen is $214.16. The cost of maintenance for the year, exclusive of labor, amounted to $90.00. The profit which is determined by subtracting the cost of maintenance from the gross receipts is $124.16 for the entire flock or $2.07 per hen.

In the second year there is a decrease of 1,337 eggs. This means a shrink of 13 percent and a loss of 46 cents per hen, or a total loss of $27.60 for the flock. Such a decrease, however, is not great enough to warrant one in discarding the fowls after the first year. It must also be borne in mind, that during the second year the birds are more mature and consequently are better fitted to be used as breeders.

As has been mentioned above a shrink of 13 percent was manifested during the second year of the experiment. This decrease while not large enough to bring about serious financial loss is but the average of sixty selected birds, and it will be of practical interest to note the shrink in the egg production, of a general flock of 240 fowls, during the second year. One can see at a glance that in this case the shrink in the general flock, (Table I) which has had proper conditions of housing and feeding, is slightly less than it was in the case of the 60 selected fowls. These figures strengthen the assertion, that the decrease in egg production during the second year is not great enough to keep one from realizing a good profit.

TABLE I SHOWING PERCENT. SHRINK DURING THE SECOND YEAR.

No. birds.	Total production First year.	Total production Second year	Percent. shrink.
240	30,40 eggs.	27,441 eggs	8.5

In the third year the 60 fowls produced 6,907 eggs or an average of 115.1 eggs per hen, a shrink of 32.2 percent as compared with the first year's production or a decrease of 56.2 eggs per hen. This means a financial loss of $1.17 per hen, as compared with the first year's profit, or a total loss of $70.20 for the flock of sixty fowls. It is doubtful if the average farmer realizes that practically all the fowls over two years of age (and there are many thousands of them on the farm) are being maintained at such a loss. True, in many instances the farm fowl is virtually compelled to forage for the greater part of its living, and if "biddy" manages to produce from 40 to 50 eggs during the spring months, the farmer figures that it is clear profit for him. While we cannot but admit that this is true, does it not behoove the progressive farmer of today, if it is within his power, to realize a profit of from one dollar to one dollar and fifty cents per hen on birds between one and two years of age, instead of forty or fifty cents per hen on old stock? The farmer who harvests his grain with a cradle and mows the meadows with a sythe, can hardly expect to keep abreast with his neighbor who employs the modern mower and binder. The former may contrive to eke out an existence while his neighbor is making a conservative profit and enjoying many of the luxuries of modern civilization.

The Value of the Trap-nest.

Of the many different trap-nests now in use there are several which are very satisfactory, but for the farmer they require too much time and expense to justify him in using them. They occupy, however, an important place in the improvement of the poultry industry throughout the country. The establishment of Agricultural Colleges and Experiment Stations, which have for their purpose the advancement of Agriculture, has opened a way in which many of the difficult problems relating to the farm may be investigated and solved. The use of the trap-nest in the poultry departments of these institutions has made it possible to carefully study the difficult phenomena relating to egg production.

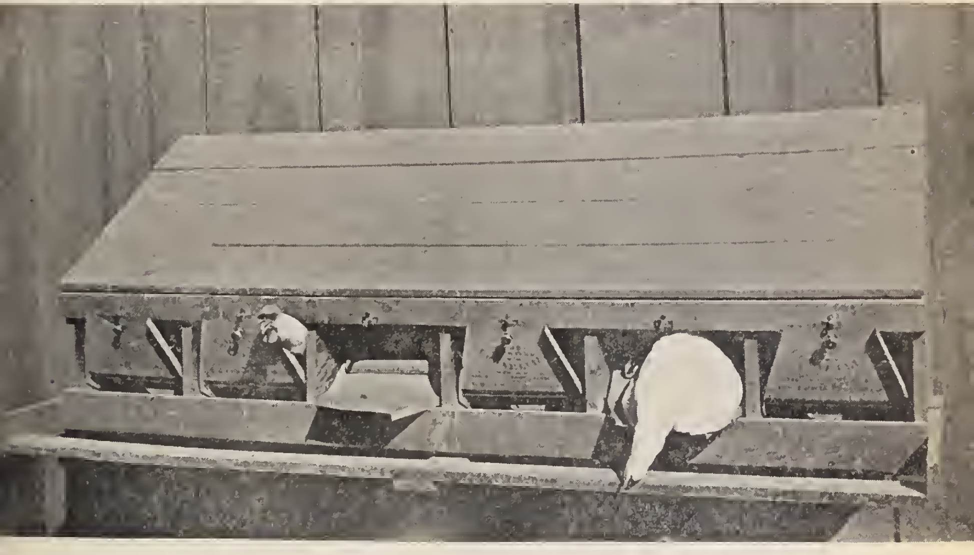


Illustration showing working of trap nest. Hen is seen entering; one is ready to be taken out; three nests are occupied and one is open.
Photo by Waite.

TALBE II,—INDIVIDUAL YEARLY EGG RECORD.

Hen No.	first year	second year	third year	Hen No.	first year	second year	third year
51	169	162	144	78	186	126	115
54	168	192	146	86	207	172	174
60	164	178	158	172	166	157	86
62	162	120	102	178	156	144	122
73	190	142	81	189	196	112	97
76	152	119	136	190	185	186	171
78	158	93	92	191	188	146	100
82	165	140	108	195	217	161	132
83	149	124	102	199	161	59	25
84	146	104	107	208	156	140	102
95	180	126	102	211	239	183	148
97	173	151	156	215	144	110	111
98	189	187	10	217	158	163	154
110	191	142	111	218	169	210	159
118	181	135	80	221	205	170	171
121	164	96	102	223	158	113	82
124	187	147	83	224	165	133	108
125	164	212	163	236	182	107	82
126	176	135	131	238	142	178	101
127	216	199	167	239	143	221	111
131	155	165	123	253	169	202	101
132	166	147	180	256	178	152	91
139	175	165	128	257	179	159	113
147	179	142	111	260	147	114	90
149	187	161	121	264	188	115	113
156	179	175	134	265	162	153	131
159	166	145	99	270	161	177	122
165	157	152	25	272	151	155	101
166	169	177	148	276	145	140	117
170	153	112	97	290	147	140	130
Total	5,130	4,447	3,447	Total	5,150	4,498	3,460
					5,130	4,445	3,447
				Grand Total	10,280	8,943	6,907

In table II is given an individual yearly egg record of the 60 fowls for the three years that the experiment was conducted. It is from table II, that table III and IV were compiled and in the discussion of the two latter tables we can readily see how the results obtained from the use of the trap-nest can be applied to the farm flock.

The purpose of table III is to indicate the month that the first egg was laid by both good and poor producers. This table is made from the pullet year record in order to be of the most value to the farmer. The pullets were hatched in March and April and it is very probable that some of them laid several eggs before they were housed in the fall as nests of eggs were found in the weeds and under the colony houses. It will be noted that 100 percent of the five hens, producing two hundred eggs and over, according to the trap-nest record, laid their first egg in November. Of those pro-

TABLE III,—SHOWING MONTH FIRST EGG WAS LAID BY GOOD, AND POOR PRODUCERS, DURING PULLET YEAR.

Total yearly Production	No. birds	% laying first egg in Nov.	% laying first egg in Dec.	% laying first egg in Jan.	% laying first egg in Feb.	% laying first egg in Mar.
200 and over	5	100.	.00	.00	.00	.00
150 to 200	56	55.4	30.4	14.2	.00	.00
100 to 150	109	23.9	48.6	23.9	3.6	.00
Less than 100	54	3.7	31.5	44.4	13.	7.4
Total	224					

ducing from 150 to 200 eggs 55.4 percent laid their first egg in November and 30.4 percent produced their first egg in December. Of those producing from 100 to 150 eggs only 23.9 percent laid their first egg in November, while 48.6 percent produced it in December and 23.9 percent in January. Of the fowls producing 100 and under only 3.7 percent laid their first egg in November, while 44.4 percent the first egg in January and 13. percent in February. A comparison of these percentages clearly indicate that the good producers are those which begin to lay early in the fall and winter, while those that do not begin to lay until late in December and the early part of January are as a rule the poor producers. The lesson to be learned from table III is that the use of the trap-nest in the poultry departments of our Colleges and Experiment Stations, has made it possible to furnish information to the farmer which will enable him to select his good producers, during the fall and early winter, without the aid of the trap-nest. The selection of the early layers does not necessarily mean that 100 percent of them will be good producers, but the farmer may rest assured that from 80 to 90 percent of them will make records far above the average of his flock.

The results of several years'work, in relation to the selection of good producers as a means of increasing the egg production, have not been very fruitful. It is not, however, the intention of the author to here discuss the various phases of this most difficult problem; but simply to suggest that even though we have not been able to transmit from mother to daughter the power to produce 200 or more eggs, we cannot possibly decrease the egg yield by breeding from strong, healthy, good producers. The selection of the early layers will enable the farmer to secure such specimens for his breeding stock.

Individual Variation.

A perusal of table 4 will show that in some instances fowls will make their greatest egg yield during the second year. This point, however, is of little importance since the percentage of fowls which might manifest this tendency is, as far as we have been able to determine, very small. Of the sixty fowls in this experiment, only 16.7 per cent. made their maximum production during the second year. A performance of this nature is probably due to retarded egg production during the pullet year, which in this instance was undoubtedly caused by lack of maturity when the pullet record was started. In this particular experiment, the records for all fowls was started at the same time regardless of whether or not they had produced an egg. It can readily be seen therefore how an immature fowl might not start to lay until several months after the records were started, and consequently would be very apt to make a greater record during the second year.

Other causes for such performance might be found in the invasion of disease during the pullet year, or in an early moult sometimes caused by an over development during the growing period. Any condition which would tend to irritate or disturb the fowls is almost sure to retard egg production.

TABLE IV,—INDIVIDUAL VARIATION.

Hen No.	First year.	Second year.	Third year.
54	168	192	146
60	164	178	158
125	164	212	163
166	169	177	148
217	158	163	154
218	169	210	159
238	142	178	101
239	143	221	111
253	169	202	101
270	161	177	122
272	151	155	101

THE ELIMINATION OF THE OLD FOWLS

Extended observations in Maryland and several other States have established the fact that at least ⅕ of the mature fowls on the farm are of questionable age. It has also been determined that very few of the farmers have any definite system of telling the age of the fowls. In the discussion of the previous pages we have learned that this condition is responsible for the low egg production that exists in Maryland and many other States. It is, therefore, obvious that a positive method for determining the age of the poultry, would in a great measure tend to increase the average egg yield of the Maryland hen.

There are two ways in which the farmer may mark his poultry so that he can tell absolutely the exact age of any fowl: first, by leg banding; second, by punching the web of the foot of newly hatched chicks. The former method consists of banding the leg of the fowl with small, numbered or lettered bands of aluminum, wire and composite metals. This method is eminently satisfactory for the man who makes a specialty of poultry raising and breeding, but for the average farmer the latter method is quicker, cheaper and more practical. With the latter method one operation marks the bird for life, while in the former the bands have to be changed from time to time as the chick matures.

In figure IV are given ten ways in which chicks or fowls may be marked. The operation is quite simple and practically painless.

To successfully perform it one should have a small poultry punch, which can usually be procured from your hardware dealer, or an ordinary awl with a hole about one-sixteenth of an inch in diameter. If the punch is used the chick is held in the hand and the toes spread apart until the web is perfectly flat, the punch is then inserted between the toes, care being exercised not to puch too far back as there is danger of cutting the foot. Where the awl is to be used the chick is held securely in the left hand and the feet placed on a small wooden block which will tend to flatten the web out so that the hole

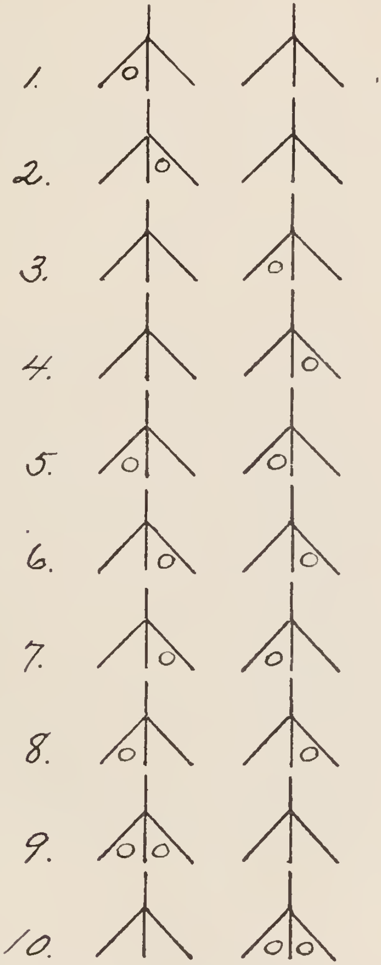


Figure IV.—Ten ways in which chicks may be marked.

can be made quickly and easily. It will be advisable to use a different mark for each year so as to eliminate all chance of confusion in determining the age of the fowls. The adoption of the above described method will enable the farmer or poultryman to tell exactly what year the fowl was hatched, and whether or not, according to age, it has passed its maximum profit producing year.

SUMMARY.

This paper constitutes a practical thesis on increasing the egg production of the farm fowl. It deals with simple, general phenomena relating to egg production. The data on which the work is based are trap-nest records; of sixty selected fowls, covering a period of three years, of 240 fowls during the first and second years and also observations of general farm conditions in several States. The chief results of the investigation are summarized in the following paragraphs:

I. That the main reasons of the low average egg production in Maryland are improper housing, injudicious feeding, lack of knowledge concerning the principles of breeding and the retention of fowls after they have passed their second year. Of these injudicious feeding and the retention of old fowls are the most important.

II. The percentage of shrink in egg production during the third year, proves conclusively that birds of this age are being maintained at a serious financial loss. It is not that they do not make a profit but the fact that this profit is too small, when compared with the returns during the first and second years, to justify the expense of maintaining them.

III. That the trap-nest records of good producers have clearly indicated that from 80 to 90 percent of them produce their first egg in the late fall or early winter. In other words during the months of November and December.

IV. The above condition furnishes a way whereby the farmer can select his good producers without the aid of the trap-nest.

V. By the adoption of a method for marking the fowls, the farmer will not only increase the egg production of his own flock but also add very materially in the effort to increase average egg production of the Maryland hen.

THE TIME REQUIRED FOR EGGS TO BECOME FERTILE AFTER A MALE HAS BEEN ADDED TO THE BREEDING PEN.

By Roy H. Waite.

First Test.—Experiment began February 3, 1911. Twenty single comb White Leghorn pullets, housed without runs in a ten by ten foot open front house, had been kept without male birds for three months. A cockerel of the same variety was added at 10.00 o'clock, A. M., February 3, and beginning with those laid February 4, all the eggs were saved for incubation. The following table shows the result:

Date	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
No. Eggs .	7	10	10	8	2	14	8	5	7	7	8	8	7	9	9	8
Sterile ...	7	5	3	1	0	3	1	0	0	0	0	0	0	0	0	0
Fertile ...	0	5	7	7	2	11	7	5	7	7	8	8	7	9	9	8

Every sterile and dead egg was broken and examined to eliminate any possible mistake made in testing.

Second Test.—The same house and birds were used in this experiment. The cockerel was removed from the pen March 23. Twenty-nine days later, at 7.15 o'clock A. M., April 20, he was again put into the pen and the eggs were saved and incubated as before. All eggs laid for first few days were marked approximately as to hour laid. This time the birds were allowed a small yard which they had been using for about five weeks. The result is shown in the following table:

Date	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5
No. Eggs	16	14	13	11	11	12	16	14	12	12	13	13	16	12	16
Sterile	16	9	3	2	1	1	3	0	0	1	2	0	1	1	1
Fertile	0	5	10	9	10	11	13	14	12	11	11	13	15	11	15

Two eggs laid before 11.00 o'clock A. M., April 22, (52 hrs. after) were found to be fertile.

Third Test.—A White Plymouth Rock cockerel was put into each of three pens of Rhode Island Reds, which had previously been kept without males, at 8.00 o'clock A. M., April 20, 1911. The houses were of the same size and type as those used in the previous Leghorn tests and no outside runs were given.

Eighteen birds were kept in each house. All eggs were saved for incubation and records were kept as in previous tests. The results are shown in the following tables:

Pen I.

Date	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5
No. Eggs	11	7	9	4	8	4	6	7	6	5	7	8	5	4	6
Sterile	11	7	5	2	5	0	3	2	1	0	1	1	1	0	1
Fertile	0	0	4	2	3	4	3	5	5	5	6	7	4	4	5

Pen II.

Date	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5
No. Eggs	7	8	4	7	6	4	8	4	6	3	8	4	4	4	5
Sterile	7	8	3	5	3	2	0	0	1	0	1	0	1	0	1
Fertile	0	0	1	2	3	2	8	4	5	3	7	4	3	4	4

Pen III.

Date	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5
No. Eggs	10	6	6	2	5	3	5	4	7	5	7	5	5	8	5
Sterile	10	6	5	2	3	2	1	4	2	2	4	2	1	2	2
Fertile	0	0	1	0	2	1	4	0	5	3	3	3	4	6	3

SUMMARY.

On the fourth day after the male was added in the first test with Leghorns ten eggs were laid by the twenty birds, of which seven were fertile. 50% of the eggs laid on the third day (less than 54 hours after the male had been put in) were fertile.

In the next test, using the same birds, thirteen eggs were laid on the fourth day, of which ten were fertile.

In the next test, using 18 Rhode Island Red pullets and one White P. Rock Cockerel, 4 eggs were laid on the seventh day and all were fertile, 6 were laid on the eighth day, three being fertile.

In the next test, using another pen of the same breeds, 8 eggs were laid on the eighth day, all being fertile.

In the next test, using still another pen of the same breeds, 5 eggs were laid on the eighth day, 4 of which were fertile. The next day, however, four infertile eggs were laid and from then on the fertility was not as high as in the other tests.

CONCLUSIONS.

While these results cannot be taken as conclusive they seem to indicate that it is safe to save eggs for hatching from a pen of Leghorn hens after the male bird has been in four days.

In the case of the larger or the general purpose fowl the results indicate that possibly a longer period should be allowed to elapse; seven days being the time in this instance where R. I. Reds were used. It is possible, however, that the crossing of the breeds may have had something to do with the longer period.

THE PERSISTENCE OF FERTILITY AFTER THE MALE HAS BEEN REMOVED FROM THE BREEDING PEN.

By Roy H. Waite.

First Test.—Began March 23, 1911. The same twenty S. C. White Leghorn pullets were used in this experiment as were used in the previous tests for fertility. They, however, had access to a small outdoor run from March 13, to the end of the experiment.

The cockerel was removed from the birds March 23, and all the eggs were incubated up to and including those laid on the twenty-fourth day. The table below shows the results:

Date	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. Eggs	12	16	10	11	17	13	13	12	13	15	16	14	10	12	17	12	15	11	14	13	14	10	15	14
Sterile	1	1	0	0	0	0	0	1	2	3	4	8	7	9	15	10	13	11	14	12	14	10	15	14
Fertile	11	15	10	11	17	13	13	11	11	12	12	6	3	3	2	2	2	0	0	1	0	0	0	0

Each sterile and dead egg was broken and examined.

Second Test.—Began April 20, 1911. Three White Plymouth Rock cockerels were removed from a pen of forty White Plymouth Rock pullets April 20, at 8.00 o'clock A. M. These pullets were housed in one section of an open front laying house and had access to a fair sized run. The house was fifteen by fifteen feet in size. The eggs were saved up to and including the nineteenth day, were incubated, and careful records made of the fertility. The result is shown in the following table:

Date	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	3	7	8	9
No. Eggs	24	24	17	21	22	22	19	24	23	20	27	21	20	23	18	25	22	16	28
Sterile	8	7	4	9	5	7	7	12	12	16	22	19	20	18	17	25	22	16	28
Fertile	16	17	13	12	17	15	12	12	11	4	5	2	0	5	1	0	0	0	0

Every sterile and dead egg was broken and examined.

SUMMARY.

In the case of the pen of 20 Leghorns an egg was found to be fertile that was laid after the male had been removed twenty days. In this pen the fertility held up well for 11 days.

The fertility of the eggs from the Plymouth Rock pen held up well until after the 10th day. One egg was found to be fertile which was laid 16 days after the male had been removed.

CONCLUSIONS.

This experiment would indicate that eggs laid during a ten day period after the male had been removed can be used for hatching purposes.

It also indicates that at least three weeks must elapse before one can be sure that the effect of a previous mating has passed of.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 158. SEPTEMBER, 1911.

MISCELLANEOUS GREENHOUSE EXPERIMENTS.

By C. P. Close and T. H. White.

SAWDUST IN MANURE USED FOR FLOWERING PLANTS.

Introduction.

The widespread feeling among florists and gardeners that sawdust in manure is harmful to plants, seemed to be of enough importance to demand some systematic experiments. The florists no doubt have had troubles when using this material, but with an absence of comparative data it would not be fair to conclude that the sawdust was responsible for the injury, as other conditions to which roses in particular are very susceptible may have been the cause.

The Experiments.

In the fall of 1908 an experiment was started to determine whether or not sawdust bedding in cow manure used in soil for roses and other plants in the greenhouse, would prove injurious. Comparisons were made between—(1) cow manure with sawdust bedding; (2) cow manure with straw or chopped corn-stalk bedding; and (3) cow manure without bedding, this being from cows kept on a cement floor without any bedding.

This work was carried on three years with roses in two greenhouses, carnations in a third and chrysanthemums and sweet peas in a fourth. The roses and carnations were grown on bench beds 4 feet by 45 feet divided into plots of 15 feet each. The cow manure with sawdust was used in the north plots, cow manure with straw or corn stalks in the centre plots, and cow manure without bedding in the south plots. This

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 158. SEPTEMBER, 1911.

MISCELLANEOUS GREENHOUSE EXPERIMENTS.

By C. P. Close and T. H. White.

SAWDUST IN MANURE USED FOR FLOWERING PLANTS.

Introduction.

The widespread feeling among florists and gardeners that sawdust in manure is harmful to plants, seemed to be of enough importance to demand some systematic experiments. The florists no doubt have had troubles when using this material, but with an absence of comparative data it would not be fair to conclude that the sawdust was responsible for the injury, as other conditions to which roses in particular are very susceptible may have been the cause.

The Experiments.

In the fall of 1908 an experiment was started to determine whether or not sawdust bedding in cow manure used in soil for roses and other plants in the greenhouse, would prove injurious. Comparisons were made between—(1) cow manure with sawdust bedding; (2) cow manure with straw or chopped corn-stalk bedding; and (3) cow manure without bedding, this being from cows kept on a cement floor without any bedding.

This work was carried on three years with roses in two greenhouses, carnations in a third and chrysanthemums and sweet peas in a fourth. The roses and carnations were grown on bench beds 4 feet by 45 feet divided into plots of 15 feet each. The cow manure with sawdust was used in the north plots, cow manure with straw or corn stalks in the centre plots, and cow manure without bedding in the south plots. This order was followed with all of the different flowering plants except that in the east and west rose house, the sawdust plots were at the east end and the others followed in regular order. The chrysanthemums and sweet peas were grown on solid beds.

The manure was gathered and left in a pile until some fermentation had taken place. This broke down the strawy litter considerably, but the sawdust had quite a fresh appearance when it was incorporated with the soil. The same amount was used in each case and was thoroughly worked into the soil before the plants were set.

CARE OF PLANTS.

The usual care required by these plants was given and the blooms were cut as fast as they were in proper condition.

ROSES.

The records with roses included the number of blooms, the length of stems, and the weight of cut flowers. These records were totalled and averaged for each season and appear in table I. There were forty plants on each plot 4 by 15 feet.

Table I Shows the Number of Blooms, Average Length of Stems, and Weight of Blooms for Three Years with Roses Grown on Soil Enriched with Cow Manure and Sawdust Bedding, Cow Manure and Litter Bedding, and Cow Manure without Bedding; Also the Averages of All Results.

Season	Sawdust Bedding			Litter Bedding			No Bedding		
	Number of blooms	Length of stem Inches	Weight of blooms Ounces	Number of blooms	Length of stem Inches	Weight of blooms Ounces	Number of blooms	Length of stem Inches	Weight Ounces of blooms
1908-9	551	11.4	115	525	11.3	102	570	11.1	125
1909-10	253	13.1	120	287	12.6	105	401	13.5	155
1910-11	707	15.9	313	645	16.6	352	664	16.8	301
	604	15.4	235	485	15.3	212	468	15.3	206
Average	528	13.9	196	485	13.9	192	525	14.2	197

This table shows that the average results are practically identical in length of stem and weight of blooms for all plots, and that the plots with litter bedding produced about 40 less blooms than the others. During the experiments there was very little difference in appearance between plants on the different plots, except that those on the litter bedding plots were not quite so vigorous as the others.

These results of three years of carefully conducted work show no harmful results whatever from the use of sawdust bedding in cow manure used in soil for greenhouse roses.

CARNATIONS.

The carnations had the same soil conditions as the roses and 100 plants were set in each plot of 4 x 15 feet. The records were made on number of blooms, average length of stems, and average size of blooms, as shown in table II.

This work was conducted for two seasons only.

Table II. Shows the Number of Blooms, Average Length of Stems and Average Size of Blooms for Two Years with Carnations Grown in Soil Containing Cow Manure and Sawdust Bedding, Cow Manure and Litter Bedding, and Cow Manure without Bedding; Also the Average of All Results.

Season	Sawdust Bedding			Litter Bedding			No Bedding		
	Number of blooms	Length of stem Inches	Size of blooms Inches	Number of blooms	Length of stem Inches	Size of blooms Inches	Number of blooms	Length of stem Inches	Size of blooms Inches
1908-9	1203	19.5	3.5	1232	18.8	3.5	1277	18.6	3.5
1909-10 ...	883	21.2	3.5	750	21.4	3.5	779	21.8	3.5
Average ..	1043	20.3	3.5	991	20.1	3.5	1028	20.2	3.5

These results are similar to those with roses in that the plots with sawdust bedding and those without bedding are practically the same, while those with litter bedding are a little poorer in all respects; and also that the plots containing sawdust were not only not injured, but were a little better on the average than any of the others.

CHRYSANTHEMUMS.

The soil for chrysanthemums was the same as for roses and carnations, but solid beds were used. This work covered two years, and although several varieties were grown on each plot, forty plants of Major Bonnafon were reserved for the records which include length of stems, size of blooms and weight of blooms. They were given the usual care and made good plants and flowers.

Table III. gives the results of the work with chrysanthemums.

Table III. Shows the Average Length of Stems, Average Size of Blooms, and Average Weight of Blooms for Two Years with Chrysanthemums Grown in Soil Containing Cow Manure and Sawdust Bedding, Cow Manure and Litter Bedding, and Cow Manure without Bedding; Also the Average Results of Two Years.

Season	Sawdust Bedding			Litter Bedding			Ne Bedding		
	Length of stem Feet	Size of blooms Inches	Weight of stem Pounds	Length of stems Feet	Size of blooms Inches	Weight of blooms Pounds	Length of stem Feet	Size of blooms Inches	Weight of blooms Pounds
1909	3.8	4.8	14.8	3.9	4.1	13.1	3.6	4.5	11.4
1910	2.8	4.7	12.2	2.9	4.7	12.4	2.8	4.5	13.0
Average ...	3.3	4.7	13.5	3.4	4.4	12.7	3.2	4.5	12.2

These average results do not vary much, but the slight differences are nearly all in favor of the plots with cow manure and sawdust bedding. Clearly the sawdust did no injury here.

SWEET PEAS.

The sweet peas followed the chrysanthemums. The seed was planted in pots and the plants were set in the beds as soon as the chrysanthemums were taken off. In 1908 four varieties were used,—Earliest of All, Mont Blanc, Blanch Ferry and Salopian. No separate record was kept of the number of blooming stems of each variety, they were all counted together. Each blooming stem represents two or more flowers; in the case of single flowering stems two of them were counted as one stem, or bloom.

In 1909 three varieties were used—Earliest of All, Blanch Ferry and Sunbeam. In 1910 the varieties were Re-selected Earliest of All and Christmas Pink. The records were kept as in 1908.

Table IV shows the number of flowering stems or blooms from ground beds 4 x 15 feet enriched with cow manure and sawdust bedding, cow manure and litter bedding, and cow manure and no bedding. The average number of blooms for the three years is also given.

Table IV. Shows Number of Blooms of Sweet Peas in 1908, 1909 and 1910 on Plots 3 x 15 Feet Enriched With Cow Manure and Sawdust, Cow Manure and Litter, and Cow Manure Alone; Also average of the Three Crops.

Season	Sawdust Bedding Number of Blooms	Litter Bedding Number of Blooms	No Bedding Number of Blooms
1908	4784	3802	3719
1909	4084	4433	4420
1910	2001	2201	1440
Average	3623	3478	3193

This table shows that the sawdust bedding plot gave the largest yield in 1908 and the litter bedding plot the largest yield in 1909 and 1910. However, the average yield for the three years is largest on the sawdust bedding plot. This is more evidence that sawdust was not injurious to plant growth in the greenhouse.

CONCLUSIONS.

Although the tables show slight gains for the sawdust bedding plots over the other plots, we do not feel like recommending its general use. Observations of the plants and blooms of the different plots for three years indicate that litter bedding in cow manure is not the best material, and that sawdust in cow manure is not harmful, but that everything considered we prefer to use cow manure without any bedding material whatever.

SOIL AND FERTILIZER EXPERIMENTS WITH VIOLETS.

Since violet growing in Maryland has for some years been on the wane, especially the growing of double varieties, it was decided to investigate one phase of this subject, that of soils and fertilizers. It was suspected that there might be some relation between the soil and the diseases affecting the plants. The double varieties were used in this work.

1902. In 1902 the first experiment was started on a small scale with two plots each 32 by 40 inches on a bench in a cool greenhouse. The soil in plot 1 was of a poor sandy character with one-third of its bulk of rotted street sweepings added. That in plot 2 was a heavy loam sod mixed with one-third of its bulk of well rotted manure. Twenty plants were set in each plot, they were taken from 3 inch pots and were grown from crown cuttings. Flowers were picked from October 24, 1902, until February 24, 1903. Plot 1 yielded 201 blooms and plot 2 yielded 400 blooms.

Not much of the leaf spot disease appeared, but there was more of it on the luxuriant growth of plot 2 than on the small hard growth of plot 1.

1904. Commercial fertilizers were used to note their effect upon the plants. Plots 32 by 40 inches were made on ground beds using boundary and division boards six inches wide to retain the soil which was rich, stiff garden loam full of humus. The rate per acre of the various fertilizers used on the different plots was as follows:

Plot 1—Nitrate of Soda 300 pounds.
Dried blood 1000 pounds.
Dissolved rock 600 pounds.
Muriate of potash 258 pounds.
Plot 2—Nitrate of soda 300 pounds.
Dried blood 1000 pounds.
Plot 3—Muriate of potash 258 pounds.
Plot 4—Dissolved rock 600 pounds.
Plot 5—Check.

The plants used were runner cuttings from 2 inch pots. They were set July 25, twenty to each plot. Watering and shading were carefully attended to, but the plants on plots 1, 2 and 3 failed to grow. By October 24 the plants which lived were considerably affected with leaf spot and "die back" diseases. Plot 4 was in the best condition of any.

The plants did not improve when cool weather came on so they were discarded, and the experiment ended.

1905. In 1905 there were five plots each 38 by 40 inches on the north bench of the greenhouse. The soil used was from carnation houses of a previous year and had just been cropped with cowpeas. Three parts of this soil with one part of sand, one of well rotted manure and one part of lime per plot formed the mixture used for plots 1, 2, 3 and 4. The soil in plot 5 was dug from beneath an apple tree and was similar to that in the other plots, it received the same addition of manure and lime as the others. The amounts of fertilizers used per acre were as follows:

Plot 1—800 pounds muriate of potash.
Plot 2—400 pounds muriate of potash.
Plot 3—200 pounds muriate of potash.
Plot 4—No fertilizer.
Plot 5—No fertilizer.

The plants were field grown instead of being potted as in previous years. They were set on October 21, six inches apart, thirty-six plants on each plot. Picking began on December 18, 1905, and ended April 14, 1906. The total blooms obtained from each plot were as follows:

Plot 1— 85 blooms.
Plot 2—160 blooms.
Plot 3—204 blooms.
Plot 4—343 blooms.
Plot 5—370 blooms.

The best plot was that of the soil from under the trees. The muriate of potash seemed to be harmful in proportion to the amount used, the largest amount being the worst.

1906. Fertilizers were used at intervals of from two to four weeks in plots 1, 2, 6 and 9. Manure was used on plots 4, 8 and 10. The amounts of fertilizers are given per acre.

Plot 1—Rotted sod soil, muriate of potash 200 pounds in 4 applications.

Plot 2—Rotted sod soil, muriate of potash 400 pounds in 4 applications.

Plot 3—Check.

Plot 4—Orchard soil with several crops of cow peas plowed under, one-third its bulk of scrapings from an open cow yard added.

Plot 5—Soil from under an apple tree like that used in 1905.

Plot 6—Rotted sod soil with {
Dissolved rock 600 pounds
Nitrate of soda 800 pounds
Muriate of potash 400 pounds
(Applied in 8 applications.)

(Applied in 8 applications.)

Plot 7—Rotted sod soil with one-third its bulk of half rotted horse manure.

Plot 8—Rotted sod soil with one-third of its bulk of well rotted horse manure.

Plot 9—Rotted sod soil with {
Raw Bone meal 400 pounds
Dried blood 1400 pounds
Muriate of potash 400 pounds
(Applied in 8 applications.)

Plot 10—Rotted sod soil with one-third its bulk of well rotted cow manure.

The plants were from crown cuttings and were set on August 1, thirty-six plants to each plot. Applications of fertilizers were made on August 1 and 30, September 14 and 29, October 14 and 30, November 14 and 30. A large portion of the plants died and those on plots 1 and 2 made very small growth. Picking began December 4, 1906. and continued until April 10, 1907. The number of plants which lived and the yield of blooms were as follows:

Plot 1—27 plants— 4 blooms.
Plot 2—29 plants— 5 blooms.
Plot 3—34 plants—226 blooms.
Plot 4—36 plants—625 blooms.
Plot 5—35 plants—559 blooms.
Plot 6—16 plants— 43 blooms.
Plot 7—29 plants—344 blooms.
Plot 8—35 plants—306 blooms.
Plot 9—23 plants—191 blooms.
Plot 10—22 plants—197 blooms.

There seems to be no doubt that the violet plant is very liable to be injured with soluble salts of fertilizers.

The work indicates that even when these salts are combined with the excrement of the animal there is still some injury.

The best combination was the soil from cowpea plot with cow yard scrapings added. These scrapings of the open cow yard are very low in soluble salts because of considerable leaching by the rain.

1907. The work this season was along lines suggested by the previous work. This was a comparison of different manures on the same soil.

Plot 1. Sod soil, composted for several months with ⅕ horse manure.

Plot 2. Sod soil three parts, with two parts of cow manure soaked with urine.

Plot 3. Sod soil, with cow manure picked up in pasture which was plain excrement without any urinal salts.

This season the work was necessarily delayed until the new greenhouses were completed and the plants were set on October 2. Picking commenced on November 29, 1907 and continued until March 18, 1908.

Number of Blooms, Plot 1—103
Plot 2— 94
Plot 3—245

The yield was best on the plot with the least amount of soluble fertilizers.

1908. This season the work followed along the line of sod and cowpea soils.

Plot 1. Sod soil with fresh cow excrement from the open yard.

Plot 2. Cowpea soil with fresh cow excrement from the open yard.

Plot 3. Sod soil with excrement and urine mixed from cow stable.

Plot 4. Cowpea soil with excrement and urine mixed from cow stable.

Plot 5. Sod soil with well rotted manure from old hot bed.

Plot 6. Cow pea soil with well rotted manure from old hot bed.

Plot 7. Sod soil without manure.
Plot 8. Cowpea soil without manure.

The plants were set August 8, 40 on each plot. A good many died especially on plots 1, 2, 3. Picking commenced November 20, 1908 and continued to March 26, 1909. The number of plants which lived and the number of blooms are as follows:

Plot 1—23 plants—120 blooms.
Plot 2—14 plants— 93 blooms.
Plot 3—14 plants— 68 blooms.
Plot 4—35 plants—334 blooms.
Plot 5—37 plants—180 blooms.
Plot 6—39 plants—259 blooms.
Plot 7—37 plants—132 blooms.
Plot 8—38 plants—482 blooms.

The results of the season of 1908 do not seem to be quite consistent with the previous seasons. The part relating to the soils seemed to be the same, but why the yard scrapings did not do as well as they did in previous years, is difficult to explain.

Comparing the total number of blooms on the four plots each, of the two different soils, they are:

Plots 1, 3, 5, 7, sod soil—500.
Plots 2, 4, 6, 8, cowpea soil—1168.

The best plot was the cowpea soil which received no manure.

CONCLUSIONS.

It is evident that this plant is very impatient of any excess of soluble salts in the soil especially in hot weather. For this reason the manure, which should preferably be the plain cow excrement without the urine, should be worked into the soil a month or two previous to setting the plants. The soil should be a rather stiff garden loam and should have had a season's rest from hoed crops under some shade plant such as cowpeas.

The glass houses in which violets are grown should be cool and moist, with good opportunity to ventilate. This condition could be better controlled in the old fashioned style sash houses than in the present type of high roofed, small rafter and wide glass, structures.

OLD SOIL VERSUS NEW SOIL.

In bulletin 127 of this Experiment Station, page 251, there are some remarks upon "Continuous Cropping Without Changing Soil." The fact is mentioned that soil upon which chrysanthemums and lettuce had been grown for several years seemed to have gotten at last into such a condition that the plants did not grow as well as they should do, also that lime in the form of caustic and carbonate was of no benefit to this soil.

When we moved from the old greenhouses to the new ones in the fall of 1907, a small amount of soil was taken out of the old house and put into the cool house of the new range. It was placed about six inches thick upon a bed of coal ashes confined by a concrete wall one foot high. This made a solid bed with six inches of coal ashes and six inches of old soil. Another bed was made up similarly except that a new compost was used for the top six inches of soil. These two plots were planted with chrysanthemums for the first crop and lettuce for the second crop, except in 1909 sweet peas were used instead of lettuce, which was, however, grown again in 1910. The plants on both plots started off nicely and grew well every season.

The old soil received manure and fertilizer in combination, or, sometimes only the commercial fertilizers because too much manure made the soil too light and chaffy. The plot of new soil was renewed each year and consisted of a good sod compost as ordinarily prepared for greenhouse work.

The results of all of this work are given in Table V.

Table V. Shows Average Results in 1908, 1909 and 1910 with Chrysanthemums, Sweet Peas and Lettuce on Old Soil and New Soil.

Season	Crop	OLD SOIL				NEW SOIL			
		Length of stems Feet	Size of blooms Inches	Weight of blooms or crop Pounds	Number of blooms	Length of stems Feet	Size of blooms Inches	Weight of blooms or crop Pounds	Number of blooms
1908	Chrysan-themums	4 7	5.3	25.0		5.2	5.0	28.0	
1909	"	3.4	4.1	11.6		3 6	4.4	12.0	
1910	"	2.8	4.7	12.7		2.7	4.7	12.2	
Average	"	3 6	4.7	16.4		3.8	4.7	17.4	
1908	Lettuce			15.0				14.0	
1910	"			11.4				11.2	
1909	Sweet Peas				1122				953

This table shows that the results are in favor of the new soil for chrysanthemums and that lettuce and sweet peas were better on the old soil. There is such a slight difference, however, that it is scarcely worth considering as it may have been due to something other than soil conditions.

From the above test it would seem as though the annual changing of soil for some crops at least, is quite unnecessary. There seems to have been no accumulation of disease germs in the old soil and the plants were entirely healthy.

This "old soil" has now been in continuous use for thirteen years during nine years of which it was the upper six inches of a solid bed twenty inches deep. The plant growth upon it had begun to deteriorate before the soil was moved to the new greenhouse. The removal of this upper six inches to a bed of coal ashes brought about changed conditions and good crops have been grown upon it annually since.

This might be attributed to drainage and leaching, especially to the latter, for while the drainage was good on the solid earth bed, perfect leaching was not secured. Any injurious salts or other matter that may have been carried downward into the solid bed of earth would immediately begin to rise again as soon as evaporation at the surface commenced. This is not so now with this soil on the bed of coal ashes which breaks up capillarity, and any injurious substance carried down by a heavy watering, is not very readily brought again to the surface.

NORTH AND SOUTH VS. EAST AND WEST GREENHOUSES FOR ROSES.

The question as to which direction a rose house should run to give best results is entirely a matter of opinion. In order to get the conclusions of men of experience along this line, a good many letters were sent out asking which each preferred, an even span north and south house, an even span east and west house, or a three-quarters span east and west house with the long slope to the south. Thirty-nine replies were received and they were equally divided, thirteen being in favor of a north and south even span house, thirteen in favor of an east and west even span house, and thirteen in favor of a three-quarter span east and west house with the long slope to the south. Thus we were supplied with plenty of opinions, but no real information.

In order to get at this point a 20 x 50 foot even span east and west greenhouse was built to compare in results with the north and south greenhouse of the same size and style built two years previously. It was in these two houses that the cow manure experiments were conducted.

The results of each house reported in Table VI are from three cow manure and sawdust plots, three cow manure and litter plots and three cow manure without bedding plots. Each plot was 4 x 15 feet in size. This experiment has been conducted only one year, 1910-11.

Table VI. Shows the Total Number of Blooms in the North and South House and the East and West House; Also the Number of Blooms on Plots with Sawdust Bedding, Litter Bedding and no Bedding:

Plots with Cow Manure and	North and South House. Number of Blooms	East and West House Number of Blooms	Total Blooms
Sawdust Bedding	1839	1751	3580
Litter Bedding	1592	1568	3160
No Bedding	1660	1639	3299
Total Blooms	5091	4958	

The table does not show much difference in yield of blooms, that for the north and south house being 5091 blooms and for the east and west house 4958, only 133 in favor of the north and south house.

There seem to be a difference in the amount of light in the two houses, the east and west one being brightest in fall, winter and spring, and the north and south one the brightest in summer. The foliage and flowers were of a darker color in the east and west house than in the north and south one. There was more burning of foliage in the north and south house during the fall than in the other; even with apparently the same amount of irregularities in the glass this seemed to be the case.

This work will be continued in the hope of securing some reliable information on this interesting point.

ORDINARY WATERING VS. SKINNER IRRIGATION SYSTEM FOR ROSES

The ordinary method of hose watering requires considerable time and is not always satisfactorily done. A very simple manner of spraying or sprinkling the plants from overhead water pipes is known as the Skinner System. This demands but little attention, simply the opening and closing of the valve in the supply pipe and changing the direction of the spray. This spraying or sprinkling resembles misty rainfall.

The beds used in this experiment were the side beds in each of the rose houses. Each bed contained one each of the plots fertilized with cow manure and sawdust bedding, cow manure and litter bedding and cow manure without bedding. The following table gives the yield of blooms on the different plots of all side beds in both rose houses.

Table VII. Shows the Number of Blooms from Plots Enriched with Cow Manure and Sawdust Bedding, Cow Manure and Litter Bedding, and Cow Manure without Bedding, Watered with the Skinner System and with the Hose Method; Also the Total Blooms from Both Systems of Watering.

Cow Manure with	North and South Rose House		East and West Rose House		Total Blooms
	Hose Watering	Skinner System	Watering Hose	Skinner System	
Sawdust Bedding	479	713	505	629	2326
Litter Bedding	329	647	449	541	1966
No Bedding	358	588	460	603	2009
Total Blooms	1166	1948	1414	1773	

This table shows that in the north and south house the beds watered with the Skinner System produced 1948 blooms, while the beds watered with an ordinary hose produced only 1166 blooms, a gain of 782 blooms in favor of the Skinner System. In the east and west house the difference was not so great, being 1773 blooms for the Skinner System and 1414 for the hose system, a difference of 359 in favor of the Skinner System.

Comparing the total results in both greenhouses we have 3721 blooms for the Skinner System and 2580 blooms for the hose system, a gain of 1141 blooms in favor of the former.

The main difference between these two methods of watering, in their relation to the growth of the plants, is, that the water from the Skinner System goes on in the form of a fine spray. This is ideal in checking transpiration in summer as the fine mist coats the leaf with a thin film of water. The same feature is good when the application of water to the soil is considered, as there is no flooding and puddling as in the case of the hose watering. It would seem necessary, however, to be able to use both systems unless some other means can be found to combat red spider other than washing it off with a hose.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 159, OCTOBER, 1911.

PEACH CULTURE.

By C. P. CLOSE AND W. R. BALLARD.

INTRODUCTION.

The peach industry of Maryland dates from about the year 1800 and has been of great importance most of the time during the past century. The cultivation of this fruit has not been free from cares, anxieties, and losses, for that insidious disease, peach yellows, has destroyed thousands of acres of trees and the destructive San Jose scale has ravaged hundreds of orchards. Late spring frosts have also taken a heavy toll of crops and for a period of several years recently the discouragements seemed to overbalance the promises of success. With the development of efficient remedies for San Jose scale and the applied elimination treatment for yellows, peach growing has taken on new life and the large plantings now being made indicate great activity in progressive peach culture in the immediate future. The intelligent use of orchard heaters practically insures against loss from late spring frost, and, everything considered, the peach seems to be entering upon a new era of success.

A great many new and valuable varieties have been introduced recently. These should be tested in all of the peach growing sections of the state for some of them will undoubtedly replace the old standard varieties. Descriptions of these are given in another part of this bulletin.

HISTORICAL SKETCH.*

Peach growing has long been one of the leading agricultural industries of Maryland. The first large orchard seems to have been planted by Thomas Robinson about the year 1800. This orchard was located in Anne Arundel county about 20 miles south of Baltimore. It consisted of 18,000 to 20,000 trees; these were all natural seedlings. It was evidently in the days of peach brandy, for the entire product of this orchard was used for this purpose.

Some ten years later, or about 1810, a number of small orchards were planted within a radius of five or six miles of Baltimore, the fruit of which was disposed of in the town. The names of Richard Cromwell, Abner Linthicum and Ellis Thomas are associated with these orchards. The one owned by Mr. Thomas was situated where Cedar Hill Cemetery now is. In 1850, or about this date, Mr. Wilson planted an orchard on Magothy River. This orchard was well cared for and was very satisfactory. It produced 21 crops in 24 years. By this time the industry had reached a considerable magnitude in this county. Some of the varieties planted in these orchards were Reybold's Early Cluster, Belle de Vetry, Orange Cling, Lemon Cling, Red Mandolin, Malecatone, Teton de Venus, George IV, Early Newington, Late Newington. Early Admiral, and Late Admiral.

---

*This Historical Sketch is copied from Bulletin No. 72 on "Peach Growing in Maryland," published in March, 1901.

Just when the first commercial orchard was planted on the Eastern Shore is not clear. It is said that Major Philip Reybold planted an orchard of 6,000 trees in Kent county about 1830, near the head of Chesapeake Bay, on what is known as Plum Point farm. It is, however, a well known fact that Major Reybold became an extensive planter a few years later. About 1830 a Mr. Cassidy planted 50,000 peach trees in Cecil county along the Sassafras river. The land on which these trees were planted was worn out but by judicious management the orchard proved very satisfactory. Mr. Cassidy was a grain merchant in Philadelphia and owned numerous teams in the city as well as a number of sailing vessels in connection with his grain business. As he thus had abundant means of transportation, he collected, so it is said, all sorts of debris from old buildings in the city and shipped it to his farm. This was applied to his orchard in liberal quantities, and, no doubt, greatly improved the physical condition of the soil. The trees were systematically pruned and well cared for and the orchard seldom missed a crop of fruit. After the owner's death in the early fifties, the orchard was badly neglected. I am told that for several years after this occurred, there still remained large quantities of the debris, which had been shipped from Philadelphia, that had never been applied to the orchard. But the orchard bore several profitable crops of fruit after this in spite of the neglect. The good care given it in the earlier years still manifested itself. Mr. Richard Semans of Cecilton and some others also planted smaller orchards about this time. The fruit from these early orchards was transported to market by sail boats or in large wagons; railroads and steamboat lines had not then been established.

"In Kent county, about 1842, Major Phillip Reybold of Delaware City, purchased land in the third district of Kent county and planted it largely to peaches. This orchard proved a success. The greatest impetus to peach planting was made from 1856 to 1865. In 1856 Colonel Edward Wilkins of Kent county, on the Chester river, commenced to plant largely and in a few years he had 1500 acres in cultivation, and in several instances he would realize a handsome fortune out of his orchards in a single season. From 1856 to 1865, peaches were planted all along the water courses in the first district of Cecil county, in all of Kent county, and in parts of Queen Anne county, until there was a continuous forest of peach trees along these water courses and extending from one to two miles back from the water; but in the interior counties on the Eastern Shore, peach planting did not commence largely until about 1867 to 1875. At this time the Delaware railroad was finished through that State and branch railroads were talked of in every county on the Eastern Shore. Trees were then planted all along the lines of these railroads."*

The canning of peaches began about the middle of the century. A son of Major Reybold was one of the first, if not the first, to develop this phase of the industry. His establishment was on what is known as "Buck Neck" farm. A Mr. Fahnestock also became interested in canning peaches about the same time. He is said to have been an extensive operator.

It will thus be seen that peach growing in Maryland, from a commercial standpoint, had its origin in Anne Arundel county, though the Eastern Shore is the section that gave to the State its prestige among peach growing areas.

---

*J. T. Shallcross in First Annual Report of the Maryland State Horticultural Society.

Peach growing in Washington county is a comparatively recent development. The first commercial orchard in this section of the State was planted in 1875 at Edgemont. Mr. John A. Nicodemus was the pioneer. There were then small family orchards but none of commercial importance. It was the behavior of these small orchards that first led Mr. Nicodemus to venture on a more extensive scale. Realizing the opportunity before him, he soon began extensive planting. His early venture comprised about 60 acres. The most of the fruit was shipped to Chip Chase Bros., a commission house in Baltimore. The package used in these early days was a bushel crate. The crates were sent to the shipper by the commission house that received the fruit.

Much interest centers about this first orchard planted by Mr. Nicodemus, though his undertaking was looked upon lightly in those days by most people. He gave the orchard good care and it was successful. It was several years before any other commercial attempts were made. In fact, it was not until Mr. Nicodemus's orchard commenced bearing that people began to realize what opportunities they possessed. In this early orchard many received their first instructions in peach growing. It was the "cradle" of the industry in Western Maryland. It is fortunate that the "father of peach growing" in this section of the State appreciated the importance of careful attention to his orchards.

The first orchard planted in the vicinity of Keedysville, which is one of the largest shipping points in Western Maryland, was put out in 1880 by Mr. W. D. Hughes. Having had some experience with peaches near Smithsburg, Mr. Hughes became possessed of a desire to extend his operations and after prospecting for a suitable place for peaches finally decided upon a mountain location about two miles from Keedysville. The first planting consisted of about 3000 trees. The next two or three years saw other plantings of nearly the same number. The prices obtained in these early years seem phenomenal when compared with present day prices. Bushel crates sold for as high as $7.00 per crate and fruit paced in the Jenkins carrier holding about one-third of a bushel brought $5.50. These prices, however, indicated that in those days peaches were looked upon only as a luxury for the rich.

It ought to be mentioned in passing, that in 1884 Mr. Hughes shipped peaches to Liverpool and to California. This, however, was intended as a test for the Jenkins carrier, rather than for a commercial enterprise. Two shipments across the ocean were made. The first was the Smock variety and was fairly successful. The second attempt was all that could be desired. Bilyeu was the variety; the fruit was picked before it was as soft as the Smock in the first shipment. So far as I know this is the first attempt in this country to send peaches across the ocean. Mr. Hughes gradually extended his operations to other sections of the county.

Closely following the first plantings in this section, came the early efforts of Messrs. A. C. and E. A. Pry. In fact, Mr. Hughes and Mr A. C. Pry prospected together before any attempt was made to grow peaches here. Messrs Pry have been gradually increasing their peach interests from the first, until now they are among the most extensive growers in the State.

Many of the Western Maryland orchards are on the Blue Ridge Mountains; the first orchards in the section were so located; but gradually extensive plantings have been made on the lower levels. Mr. Luther Barkdoll of Ringgold is said to have been the first to plant away from the mountains. Some of the most profitable orchards in the State are growing on land, the commercial value of which, within the memory of men now living, was only a penny an acre.

The foregoing is a brief outline of the beginning of peach growing in Western Maryland. Its extension and development have been merely a natural consequence of the situation. The earlier efforts were successful and others, following the lead of the pioneers, have made the industry what it is today. In a general way, this has been the line of development in all the peach growing sections of the State. The pioneer or venturer came first; he succeeded and others naturally followed.

NATURAL CONDITIONS.

Maryland is naturally divided into three more or less distinct, and as many intermediate, temperature zones. Central and Southern Maryland and the corresponding portions of the Eastern Shore, have a climate softened and tempered by the ocean, the Delaware and Chesapeake bays and the broad Potomac river. Dozens of arms of the Potomac river and Chesapeake bay reach out into the land, and scores of streams, large and small, form a complete network of water courses navigable by large boats, thus making easy water transportation direct from interior points to the great cities of Washington, Baltimore and Philadelphia. The land is low in elevation, nearly level, and largely of a sandy nature easy to work and improve.

All of that portion of the state north of what is described above is higher in altitude, colder in temperature, more or less rolling in contour, and heavier in soil types. The clay loams and mica soils predominate. On properly selected sites, peaches do well here. Washington county ought to be included in this section although it is more rugged. It contains various shale, sandstone and other good peach soils.

Allegany and Garrett counties are more rigorous in climate and are quite mountainous, but have large areas of loam and shale soils well adapted to peach growing.

SOILS.

In former years the peach seemed to be particular in its choice of soil and was partial to the sandy types. It has now become quite cosmopolitan, and will thrive on many diverse kinds, such as sandy loams, gravel loams, clay loams, mica or rotten rock soils, shales and even on quite stiff clay. The fine sandy loams with clay subsoil are especially desirable because they are easily handled and improved and suit the peach admirably. The writers believe that in most cases of peach failures it is a question of elevation and air and water drainage rather than the particular type of soil used, providing the land is not coarse sand or very stiff clay. Any soil that will produce wheat or corn ought to produce good peaches if the orchard is well located as mentioned later under the heading "Exposure and Air Drainage."

IMPROVING SOILS.

The usual way of improving soils in this State is to grow such crops as crimson clover, cow peas, vetch, soy beans, rye, etc., and plow them under to add vegetable matter to the ground. Beginning in the spring, cowpeas, one bushel per acre, should be sowed in May and if growth enough is made by the middle of August the crop should be plowed under and crimson clover seed, twenty pounds per acre, and cowhorn turnip seed one pound per acre, be sowed as soon as weather conditions permit, that is, as soon as there is moisture enough in the soil so that the seeds will germinate and grow. If the cowpeas have not made enough growth by the middle of August they should not be plowed under until the last of September or early October, when rye or winter oats should be sowed immediately at the rate of one and one-half bushels per acre. This crop should be plowed under the following May and be followed by cowpeas at once, which in August should be succeeded by crimson clover and cowhorn turnips. This cropping for a couple of years will improve the soil greatly. If commercial fertilizer can be used with one or both seedings each year, the improvement will be much more marked. The following amounts per acre are suggested for this purpose: 50 pounds nitrate of soda or sulphate of ammonia, 75 to 100 pounds of muriate or sulphate of potash, and 200 pounds of acid phosphate or dissolved bone. If the land is acid then about 20 bushels of lime per acre should be applied when soil improvement begins.

If stable manure is available it may be used in large amounts instead of the green crops just mentioned or in connection with them.

It is not necessary to delay tree planting a year or two while soil improvement is in progress. They may be planted at once and be fertilized with nitrate of soda one-fourth pound, muriate or sulphate of potash one-fourth pound and dissolved bone one-fourth pound per tree in April or early May. The next spring twice this amount of fertilizer per tree should be applied and the following spring three times as much should be given to each tree. The fertilizer should be spread broadcast two or three feet around the trunk and be well worked into the soil. The future fertilizing and cover cropping are discussed under the headings "Fertilizers and Manures" and "Cover Crops."

Exposure and Air Drainage.

On gently rolling land the highest portions are best for peach orchards because the cold air cannot settle around the trees, but instead drains off into the lower areas. The exposure does not matter much if any, except that toward the south the buds may be earlier in opening, but free air drainage does matter. It is generally understood that cold air is heavier than warm air and rolls down the slopes to the lowest levels where the latest frosts in spring and the earliest in fall always occur, and in these low places are the greatest variations in temperature.

On broad, nearly level areas, there is not always much choice in elevation, but the lower places should be avoided. Usually there is a stream or swamp in the neighborhood which helps to drain off the cold air. Orchards in level sections should be protected from late spring frosts by artificial heating, which is discussed farther on in this bulletin.

In the hilly and mountainous sections, especial care in locating orchards is essential so that there are areas below them to receive the cold air. Ravines and other natural outlets are often filled with trees and underbrush which retard the flow of air. Coves and dips on the slopes must be avoided for the cold air settles in them and injures the buds and fruit. The westerly slopes along the mountain ranges are probably best because of evenness in temperature and dryness of atmosphere. On individual hills or low mountains the exposures do not differ much except that the southern may be a little earlier and the northern a little later than the others. On the mountain ranges a southern exposure might be so much protected at the top and sides that it would warm up early in spring and cause the blossom buds to open after which a cold spell might kill them. The southern exposure is also more variable in temperature. A northern exposure in the mountains is not desirable and the eastern exposure has not always been satisfactory because of much moisture which is conducive to disease prevalence. In short, on the mountains of Western Maryland except on the highest ones of Allegany and Garrett counties, the best locations for peach orchards are on or near the tops with a westerly, south-westerly or north-westerly exposure.

In order to get the opinions and experiences of fruit growers in mountainous sections, letters of inquiry were sent out and the answers received are given herewith. It will be noticed that experiences differ in different sections so the matter of a choice of slopes is largely a local question.

Mr. A. L. Towson, Smithburg,—Prefers west and north-west slopes because there is more certainty of a crop and in case of late spring frost the sun does not strike the buds before they are thawed out; there is less fog than on the east slope or mountain top, therefore less rot and black spot. At the same elevation Salway and Bilyeu are fine and clean on the west side of the mountain and badly damaged by black spot on the east side.

Mr. Aaron Newcomer, Smithburg,—Prefers the north and west slopes because the temperature is more even and the blossoms open later than on other slopes, therefore, there is less injury from late spring frosts. On the lower elevations of the east and south slopes the mildew is very injurious.

Mr. Thomas F. Diffendal, Smithburg,—Has a peach orchard on a hill sloping in every direction and there is no difference in certainty of crop at the same elevation if the air drainage is equally good on all sides. The fruit may ripen a day or two earlier and have slightly better color on the south slope.

Mr. E. P. Cohill, Hancock,—All conditions being equal the slope makes no difference in results either on mountain ranges or detached hills around Hancock. The eastern slope generally has the best soil.

Mr. George D. Eyler, Spring Gap,—Prefers the east and south slopes because they are protected from the severe winter storms; however, the blossoms may be killed by late spring frosts. On the north and west slopes the fruit buds are sometimes winter killed and the land is not so fertile as on the east or south slopes. On a north slope in a wet season the trees and fruit do not dry off readily and the fruit rots in sultry weather. There must be good air drainage on any slope, so the fruit will dry off quickly or it will rot. The north and west slopes with pine and laurel growth are not so fertile nor so good fruit lands as the east and south slopes with chestnut and locust growth.

Mr. H. S. Krumbine, Gilpin,—Prefers a high east exposure on a north and south range so as to escape moisture; the soil there is light and warm and the trees are protected from the scalding effect of the afternoon sun in winter. On an east and west range the south exposure is best, except in the case of limestone soil the summit is preferred. The highest elevations are best for Bilyeu.

Mr. W. D. Hughes, Keedysville,—Has an orchard with a northeastern exposure and the fruit colors and does very well; there are orchards on all exposures in that section, and all do equally well.

Water Drainage.

Peach trees cannot endure water soaked ground because the excess of moisture prevents the soil activities which normally take place in well drained soils, and causes either asphyxiation or starvation of the roots. Either surface drains or tile drains are absolutely essential where the natural slope is not great enough to carry off the surplus water, and on steep slopes unplowed strips or contour furrows are needed to check the washing of the soil.

Preparation of Land.

The tree roots need a good deep feeding ground and plowing cannot be done too deeply. In stiff soils a subsoil plow ought to be used but this is seldom done. The ground should then be worked into fine tilth with the harrow, roller, etc.

Ordering Trees.

So much disappointment and loss often follow the receipt of a shipment of trees that too much care cannot be exercised in first knowing just what is wanted, and second in placing the order with a reliable nurseryman. A few good rules to observe are the following:

1. Do not buy from a tree agent unless you know him to be absolutely reliable and that he represents a reliable firm. The nurseryman is more responsible than the agent.
2. Decide on the varieties, the number of trees of each variety, the size of trees desired, and write to several reliable nurserymen for quotations on just what you want. Do not accept any substitutions.
3. Buy of the nearest reliable nurseryman who can furnish exactly what you want and hold him responsible.
4. If in doubt about the varieties to plant ask a successful fruit grower near by, or write to the Experiment Station at College Park, Maryland, for advice.
5. Always write for prices on trees and have a distinct bargain in writing before placing the order. This may save a lot of future unpleasantness.

6. Do not be mislead by gaudy lithographs of varieties which an agent or nurseryman may wish to sell, color matter is cheap and the varieties represented may not suit your locality, or may even be worthless.

7. Stipulate that all trees must be free from crown gall, San Jose scale and all other injurious diseases and insects and do not accept, pay for, or plant, trees so infested.

8. Demand low headed trees that have not had the lower branches pruned off in the nursery.

9. Do not buy poor trees because they are cheap. A good, healthy, clean tree at a high price, is cheaper than a poor tree as a gift.

10. Keep all correspondence, receipts, records, etc., for future reference.

Heeling in Trees.

If the trees are to be kept some time before being planted they should be heeled in as soon as received. If they are to be planted soon, they may be left in the package a couple of weeks providing the roots are kept moist. Heeling in consists in digging a trench about fifteen inches deep with one sloping side against which the trees are reclined with the roots in the trench. The earth from the other side is thrown over the roots and part of the trunks thus opening up a parallel trench into which more trees are placed. The earth banked over the roots should be tramped down firmly. If the trees are to be heeled in over winter the tops should point toward the south so as to shade the trunks and prevent injury by alternate freezing and thawing in mild weather.

Age and Size of Nursery Trees for Planting.

A nursery peach tree older than one year should never be purchased and a large overgrown tree is not desirable. Trees are sold according to size, the largest trees bringing the highest price. It is strange that a fruit grower will willingly pay a high price for a big overgrown tree when there is not a single point in its favor. It costs more to begin with than a much better medium sized tree, its size and bulk in numbers make the shipping charge higher, it is harder to handle, more wood is trimmed from it when planted, it cannot be headed so low and be satisfactory, it does not transplant so easily and safely, and does not find the favor for extensive plantings that it once found. The writers prefer a well grown, medium sized tree 3½ to 4 feet high with all of the low side branches on so as to use the best of these for forming the lowhead.

"June buds" are trees grown from buds inserted into the young seedlings in June. The buds are forced to grow at once, and the trees are planted in the orchard the next spring. Such trees are desirable and will vary in size from a few inches to a couple of feet.

Spring or Fall Planting.

Early spring is the best time to plant peach trees, but in mild climates they may be planted in the fall. If they are planted in the fall they should be only partially pruned when set and be repruned early the following spring.

Distance Apart to Plant.

This will depend somewhat on the fertility of the soil and the method of pruning to be adopted. On fertile land the trees ought to be set twenty feet apart each way and they will need to be well headed in. On land which needs building up and will not make heavy tree growth the distance may be eighteen feet apart or even sixteen feet each way. On light or poor soils the trees may be planted a little closer if they are headed back annually, but close planting is not advocated.

On hilly ground where contour lines must be followed, the trees will vary in distance apart depending on steepness and outline of the slope.

Laying Out the Orchard.

Any one of several methods is satisfactory for laying out the orchard. The simplest is to set tall stakes twenty feet apart along both sides and across the middle of the field, and plow straight furrows between the stakes. Cross furrows are made in the same way. A little digging out is needed where the furrows intersect and the trees may be planted. By sighting along the row, if aided by one or two stakes, the trees may be lined up fairly well.

Another method is to set stakes twenty feet apart across the sides of the field, and stretch a wire with markers twenty feet apart, between opposite stakes. A small stake is driven down at each marker to locate the position of each tree. Holes are dug and trees are lined up by sighting along and across the row, but this method requires a man or two extra to do the sighting.

A planting board made by cutting a deep notch in the middle and one near each end equally distant from the centre, is convenient. A board three or four inches wide will answer the purpose. The centre notch is placed against the stake marking the location of a tree. Then another stake is driven in each end notch and the centre stake and board are removed. The hole is dug and the planting board is replaced against the end stakes. The tree is set in the centre notch and the earth is filled in to hold it in place.

Pruning Trees for Planting.

All broken and bruised roots should be trimmed back to sound wood, and all roots should be cut to from four to six inches in length. Small fibrous roots may be cut even shorter. There is no necessity for leaving the roots longer than six inches and experiments have proven that for this latitude peach trees do best when trimmed as just mentioned.

The top should not be trimmed to a "whip," as so often advised, but rather to "spurs," that is, every twig should be cut off so as to leave two or three buds on it. Limbs broken at the trunk must of course be entirely removed. The object of trimming to "spurs" is to relieve the tree from the effort of healing trunk wounds caused by "whip" pruning, and to encourage abundant leaf formation all along the trunk to shade it, to enlarge its size and to increase the movement of sap and plant food to all parts of the tree. A newly planted tree has a struggle to become established and should not be compelled to heal trunk wounds as soon as set.

The top should be cut off at whatever height it is desired to have the head, from 12 to 24 inches being about right. The low heading of fruit trees is being practiced more each year.

Advantages of Low Heading.

Fortunately, the old style of high headed peach trees is going out of favor with progressive fruit growers, and the common sense method of low heading is taking its place. There are really no disadvantages with low headed trees if they are properly pruned each year as mentioned under "Pruning the Trees." The limbs will be short and stout and ascend obliquely so as to be out of the way of orchard implements, especially the extension implements.

The low headed trees have the advantage of high headed ones in being easier and cheaper to spray, prune, and gather fruit from, and in less injury to dropped fruit and less injury by storms. The fruit will color and ripen as well on low trees as on high ones. Fruit growers should demand low headed trees from nurserymen.

Planting the Trees.

In mellow and well prepared soil the hole need be only wide and deep enough to receive the tree easily. In hard ground or sod, it should be three feet or more across and deep enough to set the tree two or more inches lower than it stood in the nursery. For opening up hard or rocky ground there is no method so good as the new one of exploding about one-third of a pound of dynamite two or three feet below the surface where the tree is to stand.

Hold the tree in position, shovel in the mellow top soil, "joggle" the tree up and down slightly to settle the earth around the roots, tramp or pack the earth firmly around and over the roots, fill up the hole, pack well and throw a little loose earth on as a mulch to retain moisture. In carrying the trees from hole to hole they should be wrapped in wet burlap or other material to prevent the roots from drying out. It is also well to dip the roots in thin mud as soon as they are pruned if planting is not done at once.

PRUNING THE TREES.

The principal reasons for pruning peach trees annually are: (1) to form stocky, strong trees; (2) to force out new growth each year for bearing the crop next year because peaches are always borne on *one year old* limbs; (3) to head back the leading branches, or leaders, to make lower tops; (4) to thin out surplus growth to make open tops so sunlight can reach all fruit and color it; (5) to make symmetrical tops and (6), indirectly, to thin the fruit. Sometimes the entire top is cut off leaving only stub limbs to grow a new top.

The one most common error made and the hardest to correct, is pruning from the *bottom upward* instead of from the *top downward.* Pruning from the bottom upward means cutting all of the lower limbs from the foundation branches making long-legged, bare-limbed trees with the tops many feet above the ground. Pruning from the top downward means heading back the leaders, and other limbs when necessary, and keeping the tops near the ground.

The figures which accompany this text and represent trees pruned and unpruned, are from drawings by W. R. Ballard and are mostly adapted from illustrations in the Delaware Experiment Station bulletin No. 62, by C. P. Close, on "Pruning the Peach."

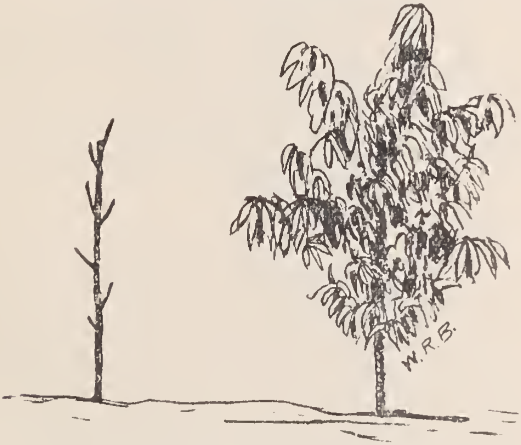


Fig. 1—Young tree planted and pruned.
Fig. 2—Same as figure 1 with three months growth.

First Year.—As already mentioned, the trees when planted should have the limbs cut to spurs two or three inches long and the top cut off from one to two feet above the ground, see figure 1. All of the buds should be allowed to grow so the trunk will be feathered out during its entire length as shown in figure 2. The branches may grow at will during the season, or the careful man may pinch out shoots as required to form his ideal of a well balanced top.

Second Year.—The trees have grown one year and now the amount and kind of pruning depend upon the length of growth and number of limbs. From three to five foundation branches should be selected to form the framework of the tree, and all others should be cut off close to the trunk. The limbs retained should be distributed around the trunk, each pointing in a different direction, and come out at different heights above the ground, thus forming a symmetrical top, or head. All limbs which form a crotch with the trunk must be taken off at once or be treated as mentioned later. Usually about one-third of the length of the main part of each foundation branch or "leader" is cut off and the cut is made just above a side limb so no stub is left and the wound will heal. The side limbs on the foundation branches below the cut just made are left, and they are not even shortened in unless they are long and willowy. This is illustrated in figures 3 and 4, which represent a vigorous Champion tree of one year's growth. When this tree was planted in March it was pruned to spurs and cut off three feet from the ground. The growth of about five feet shown in figure 3 was made in one season. Figure 4 shows how the tree was pruned cutting back the leader branches just above side limbs and retaining the side limbs. In this case there were no surplus branches to be removed.

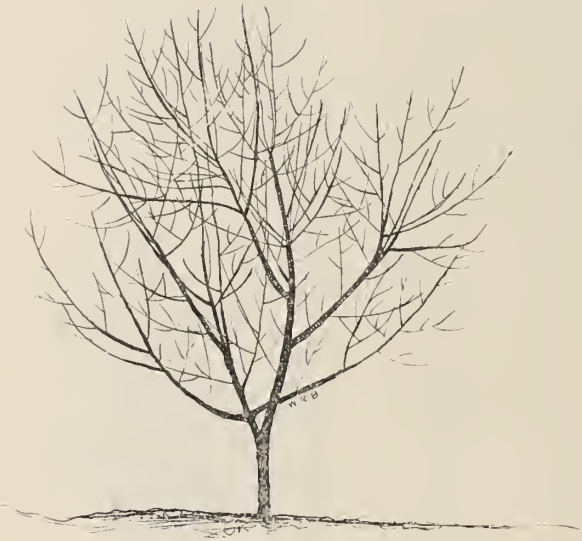


Fig. 3—One year old Champion peach tree.

The lowest branch in figures 3 and 4 looks as though it formed a crotch with the trunk, but in reality it did not do so. However, it illustrates two points—first, how easily a crotch is formed with the main trunk in which case the branch must be cut off at once if it can be spared, because a crotched tree breaks down sooner or later; and, second, how a branch forming a crotch may be saved, if it is essential to the symmetry of the tree, by cutting it back much more than is shown in figure 4 to subdue its development while the trunk is growing and strengthening the union. This is thoroughly practicable with young trees, but on older trees the crotch forming limb must be sacrificed.

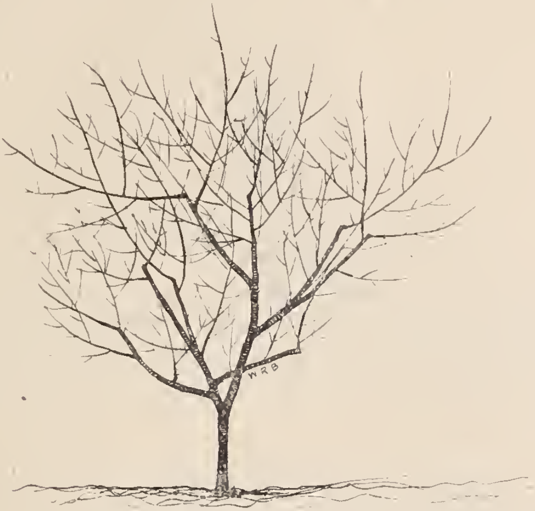


Fig. 4—Tree in figure 3, pruned.

Figure 5 represents the first year's growth of a low headed, well shaped tree with four foundation branches ideally placed. Figure 6 shows this tree properly pruned by cutting back the leaders which are the foundation branches of the first year's growth. They will become

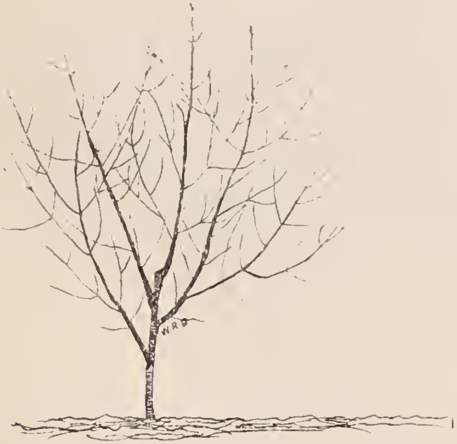


Fig. 5—The first year's growth in the orchard.

stocky, and strong and support heavy loads of fruit without any breaking and with little bending.

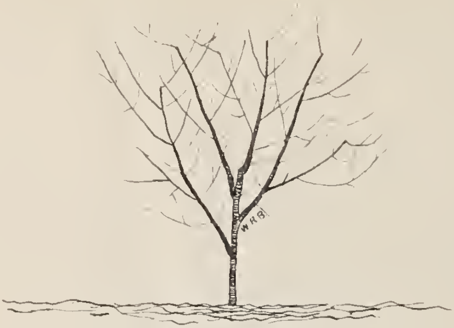


Fig. 6—Same as figure 5, pruned.

A few years ago the authors believed in pruning one year old peach trees much more severely than they do at present as is shown in figures 7 and 8 and 12 and 13. The first year's growth of the tree

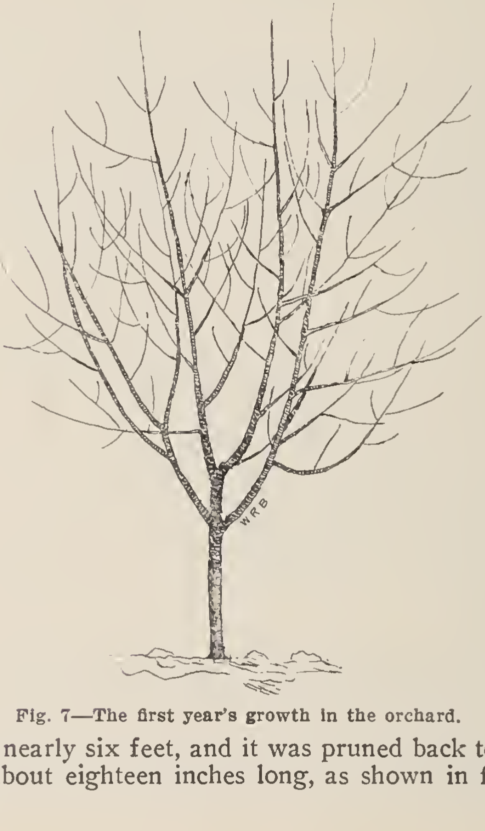


Fig. 7—The first year's growth in the orchard.

in figure 7 was nearly six feet, and it was pruned back to four foundation branches about eighteen inches long, as shown in figure 8. This was in March, 1902. Such severe pruning forces a tree to send out a large number of shoots which form a bushy top and must be thinned out in May or June leaving only the shoots necessary to form a good head. That this tree took kindly to its pruning is shown in figure 9, which represents it nearly seven feet high in October, 1902. A nicer shaped tree than this could hardly be desired. The foliage extends down the foundation branches nearly to the trunk and this is most desirable. Figure 14 shows the same good point.

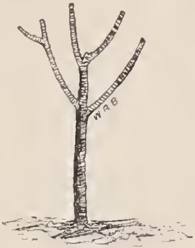


Fig. 8—Same as figure 7, pruned in March, 1902.

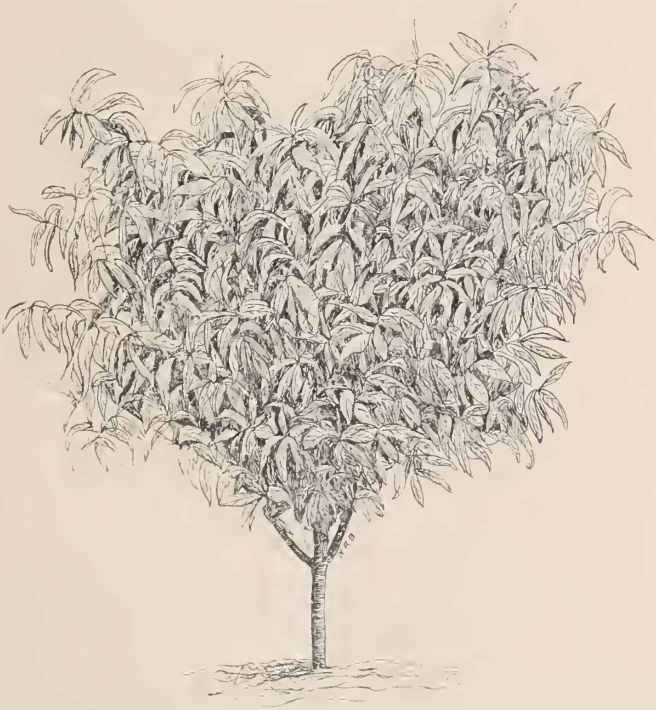


Fig. 9—Same tree as shown in figure 8, photograph taken in October, 1902.

Figure 12 represents another vigorous one year planted tree too severely pruned, as shown in figure 13. This tree was headed very low when planted, had made a growth of more than five feet and was cut back to two feet above the ground in March, 1902, figures 12 and 13. A most vigorous new growth started which with some thinning out of new shoots made in seven months the beautiful tree six feet high shown in figure 14. This tree was headed a little too low, but otherwise can hardly be improved. Figures 8 and 13 show how *not* to prune peach trees of one year's growth because it is more difficult to shape them up well later. That this can be done, however, is shown in figures 9 and 14. Figure 6 shows the best method of pruning the first year's growth.

Shearing Young Trees.—Sometimes peach trees are sheared in symmetrical outline like a hedge is trimmed. This method is wrong in principle and bad in practice resulting in thick bushy tops and small short growth.

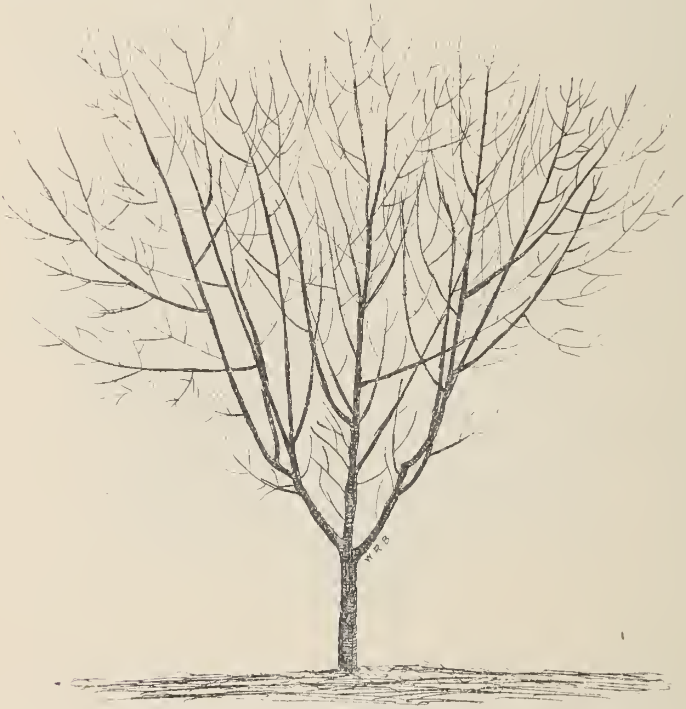


Fig. 10—Same as figures 7, 8 and 9, photograph taken in March, 1903.

Third and Following Years.—The method of pruning after the second year is about the same as described for the first and second years. Surplus branches and dead or broken limbs must be taken out. The leaders and long side limbs must be shortened in to keep the top low and strong. The amount of shortening in depends on the growth and varies from a few inches in short growth to two or three feet in heavy growth. The other side limbs with the bearing twigs must not be pruned. All cuts should be made just above a side limb or bud. Annual pruning should be practiced so as to produce plenty of new bearing wood each year. Pruning should be from the top downward instead of from the bottom upward. In removing limbs the cut should be made right up to the trunk or supporting branch so no stub whatever is left. Wounds one inch across or larger should be covered with thick paint or grafting wax.

A few pictures will illustrate this pruning better than it can be done with words. Figure 8 shows the tree in figure 7 pruned in March, 1902, and figure 10 shows the same tree one year later, March, 1903, over six feet high. Figure 11 shows how the tree in figure 10 was pruned. Unfortunately, the camera was so placed that the fourth foundation branch was hidden by the opposite branch which appears in figure 10 to be a straight central leader, but it is not so. The top has an open center and all four foundation branches are shown in figures 7 and 8. The criticism of this tree is that the foundation branches are too close together; they ought to be distributed along the trunk.

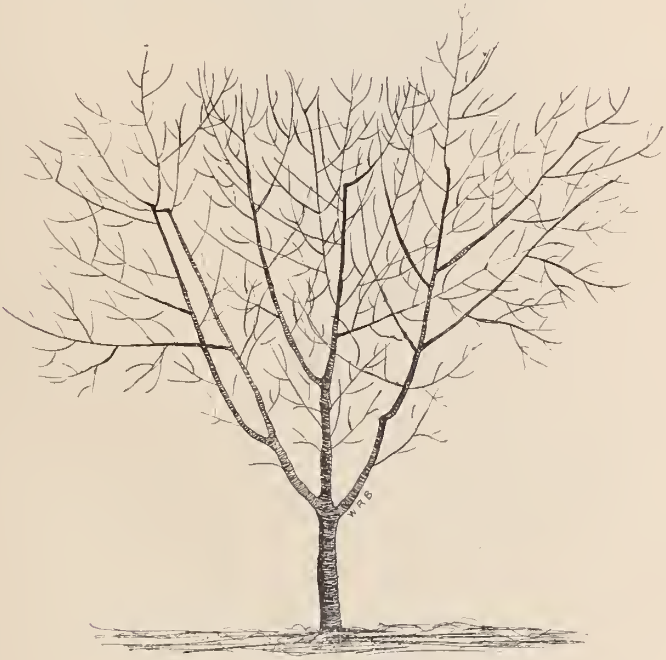


Fig. 11—Same as figure 10, pruned.

The tree in figure 13 is shown one year later in figure 15 and the way it was pruned in figure 16. This is the same tree shown in figures 12, 13 and 14. It was headed a little too low. The cutting back of leaders is nicely shown.

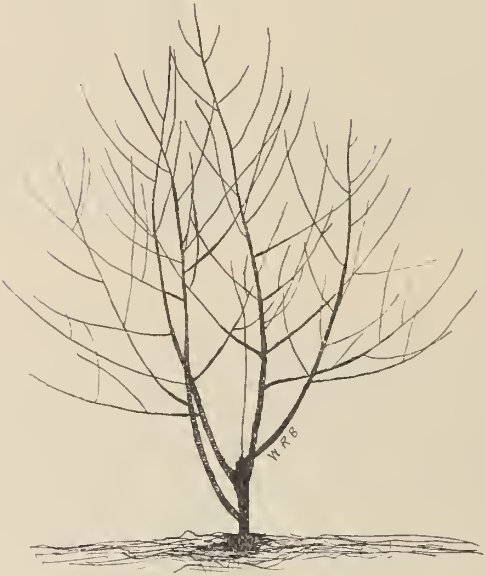


Fig. 12—First year's growth in orchard, low headed.

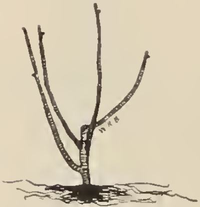


Fig. 13—Same as figure 12, pruned in March, 1902.

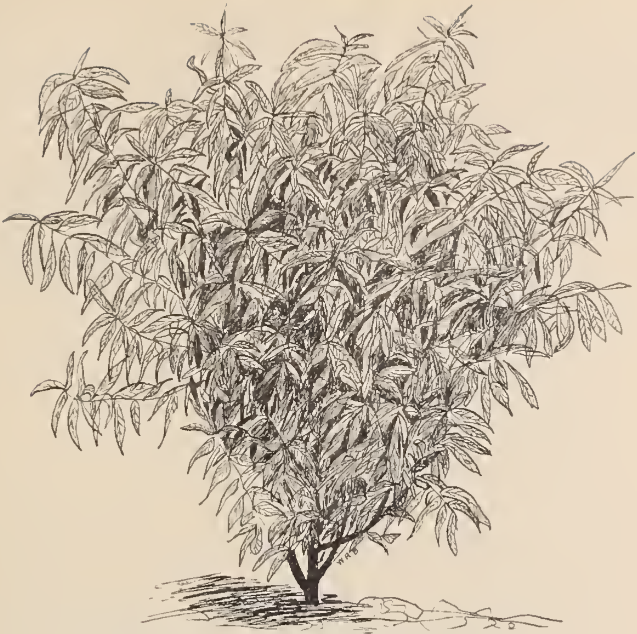


Fig. 14—Same as figure 13, photographed in October, 1902.

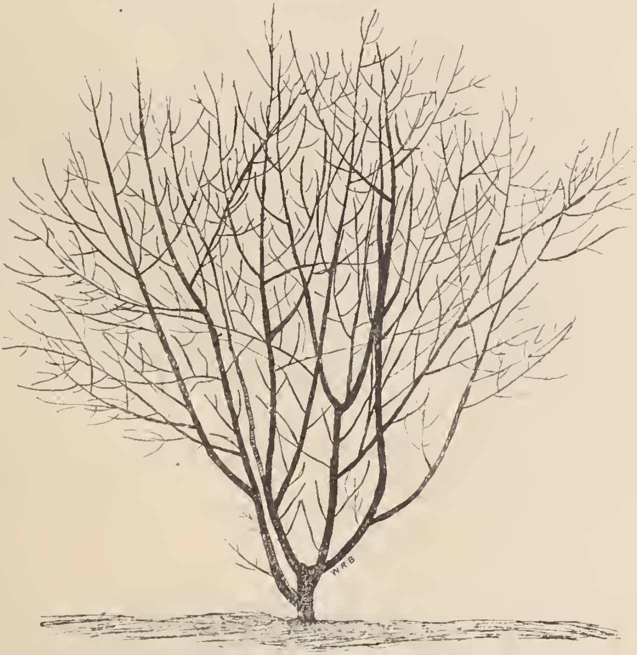


Fig. 15—Same as figure 14, photographed in March, 1903.

It is not necessary, except for appearance, to trim out all of the surplus, small, central shoots on the main branches. These finally die and drop off, but while they last give the trees a neglected look during the dormant season.

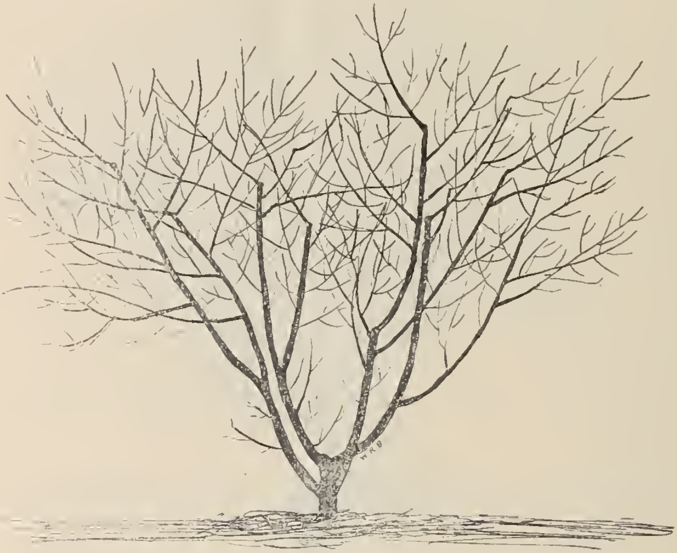


Fig. 16—Same as figure 15, pruned.

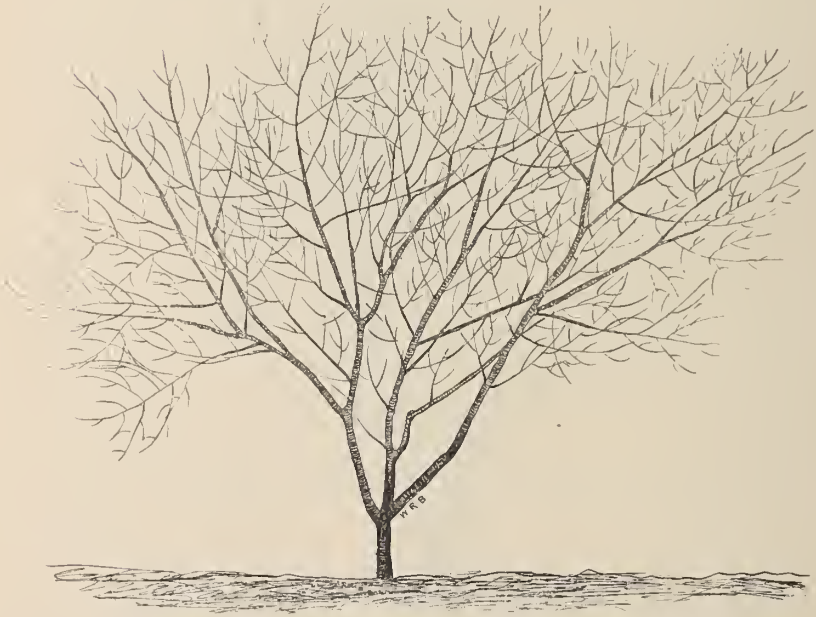


Fig. 17—A five year old Elberta which was never pruned.

PRUNING NEGLECTED PEACH TREES.

There are thousands of long-legged, bare-branched, high-topped peach trees in Maryland which can be brought back into pretty good shape by the same general methods already discussed. Figure 17 shows a five year old Elberta tree about fifteen feet high that was never pruned since being planted. The leaders were cut back from three to six feet as shown in figure 18, and the top was thereby lowered about four feet; no thinning out was necessary. An abundance of bearing wood was left on and a vigorous growth followed.

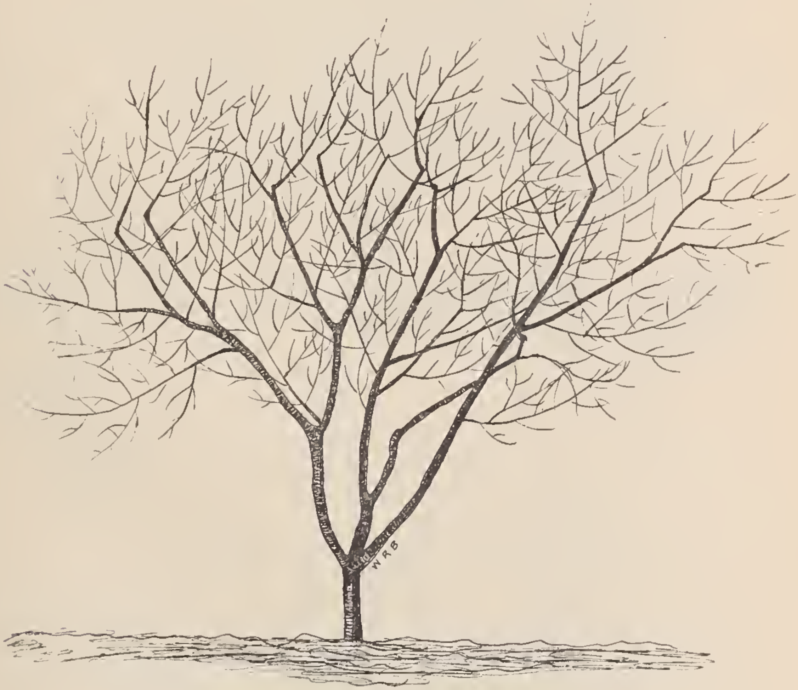


Fig. 18—Same as figure 17, pruned.

Figure 19 shows a large three year old Francis tree which never knew pruning-saw or shears. After some thinning out and heading back it presented a very respectable appearance as shown in figure 20.

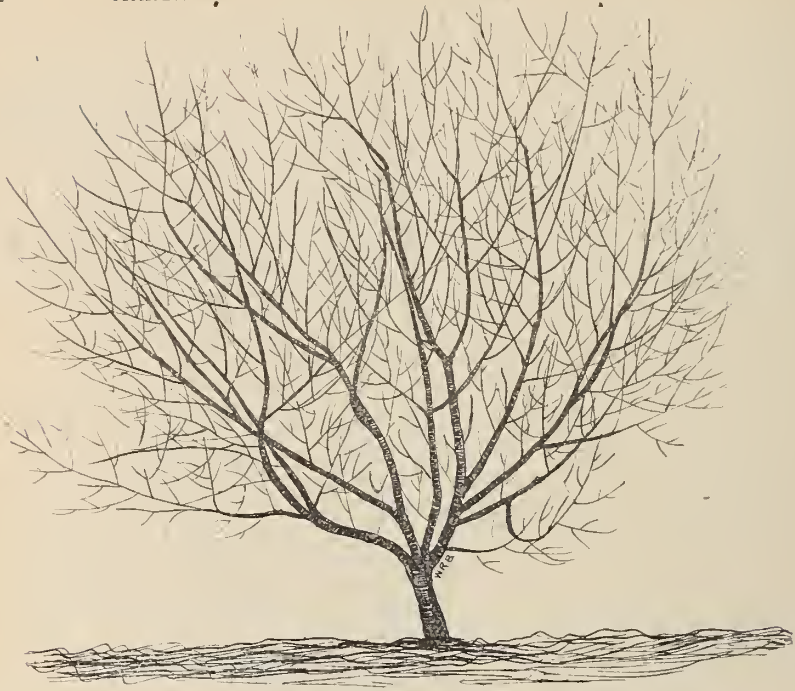


Fig. 19—A three year old Francis tree which was never pruned.

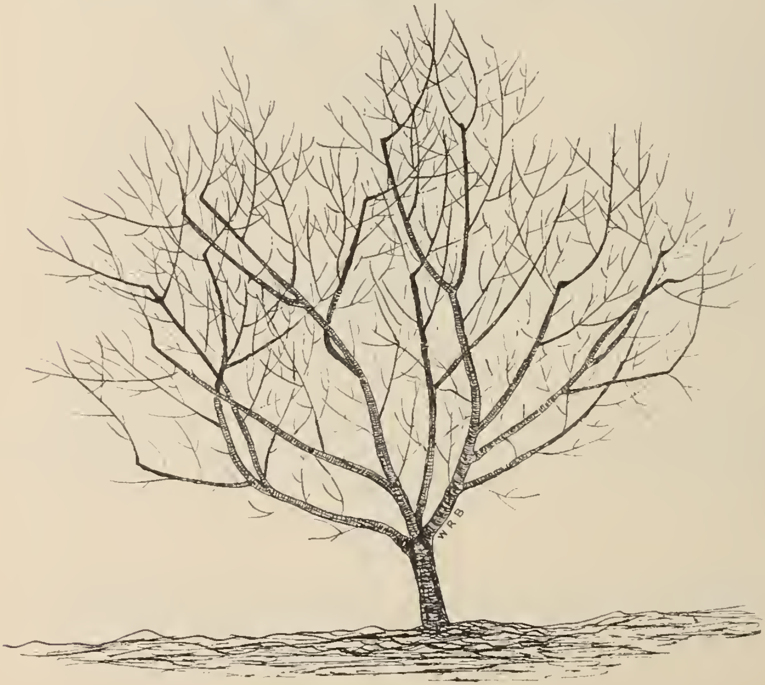


Fig. 20—Same as figure 19, pruned.

An old Reeves tree twenty feet high is shown in figure 21. Because of its very long bare branches with only a canopy of bearing twigs at the top, it is a difficult subject to reduce to desirable height and shape. About the best treatment for it is to stub-prune (de-horn) all of the main branches as shown in figure 22, which is a stub-pruned five year old Troth tree. Such heroic pruning forces out a low, new vigorous top which usually bears the second year following. Considerable thinning out of new shoots is necessary or the top will be too dense. Figure 23 shows two months' growth of top on a stub-pruned tree similar to that shown in figure 22.

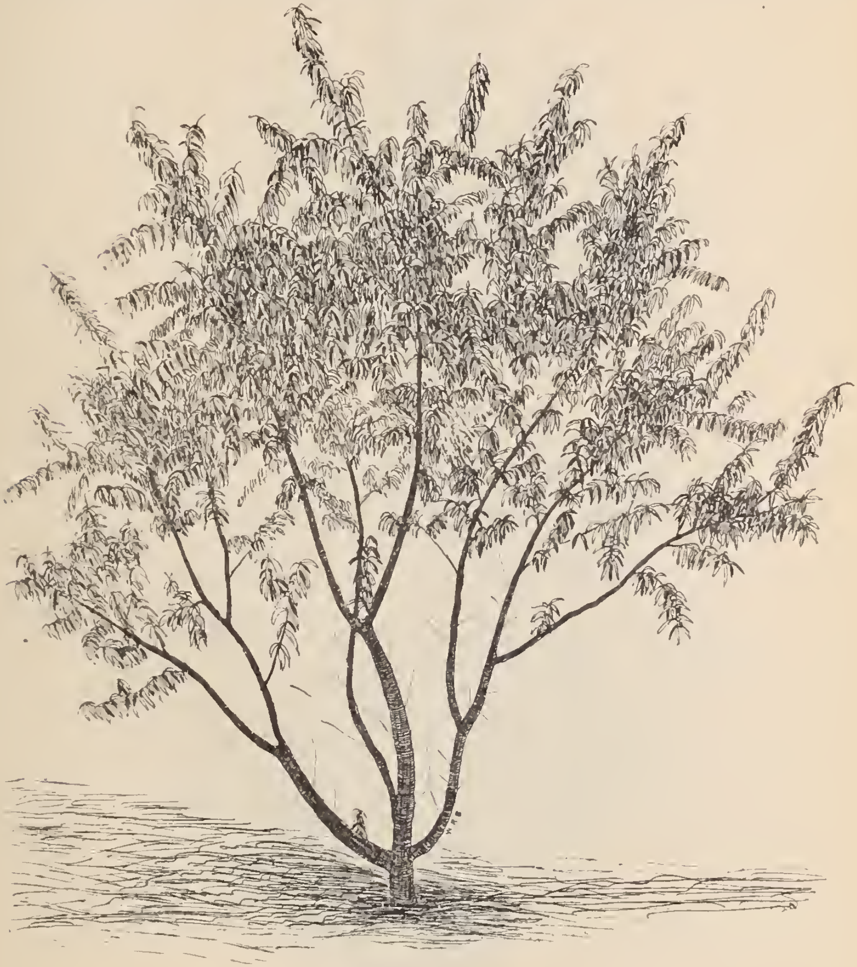


Fig. 21—An old Reeves tree 20 feet high.

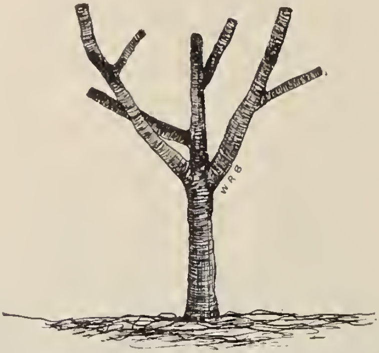


Fig. 22—A five year old tree stub pruned (dehorned).

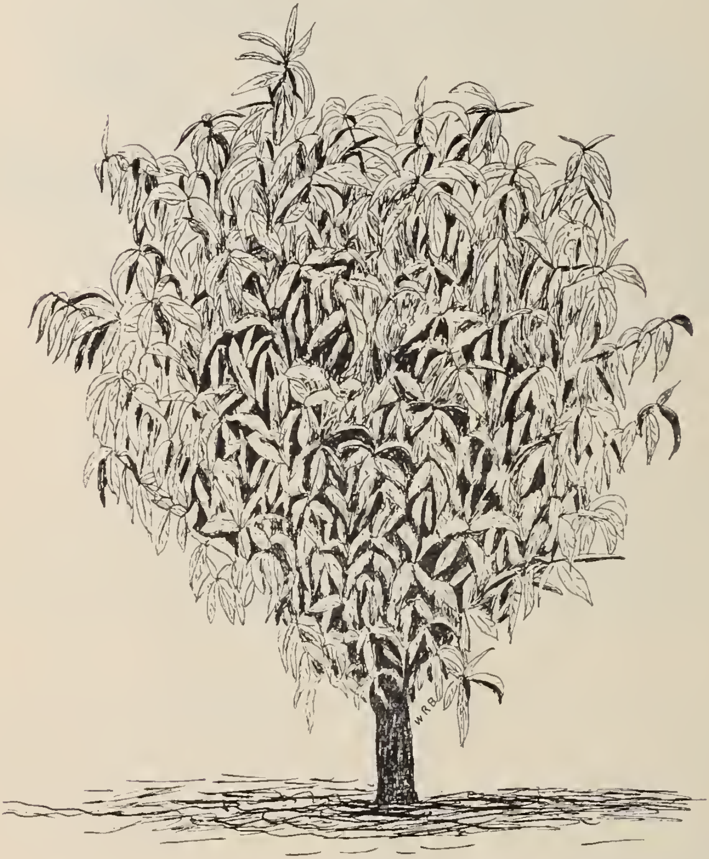


Fig. 23—A five year old tree, stub pruned, with two months' growth of new shoots.

MUTILATED PEACH TREES.

The most common form of mutilation is shown in figure 25 where the cutting of lower limbs leaves long bare foundation branches. Figure 24 shows the same tree in fine, symmetrical condition before the

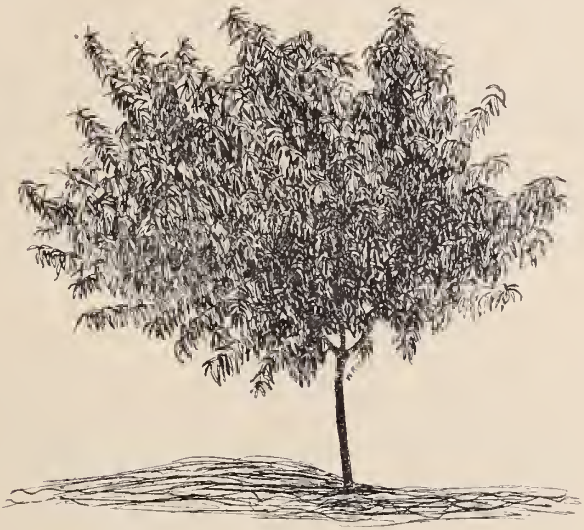


Fig. 24—A three year old peach tree.

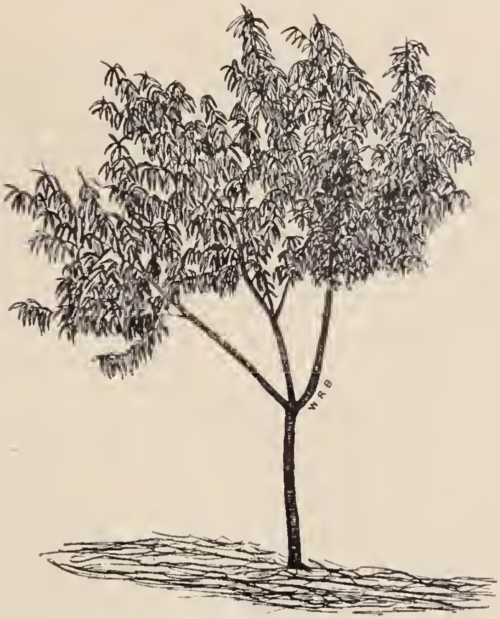


Fig. 25—The tree shown in figure 24 mutilated with the pruning shears.

owner mutilated it. The tree was three years old. The foundation branches are, of course, not well placed.

The leaving of stubs a few inches long when cutting off limbs is another form of mutilation.

When to Prune.

The best time to prune is early in the spring when danger from heavy freezing weather is past, because the work can then be done with reference to the proportion of fruit buds still alive. If most of the fruit buds are winter-killed, then less pruning is done so as to save as many live buds as possible. If the buds are nearly all alive then the pruning may be as severe as necessary.

Winter pruning is undesirable, because low temperatures later may destroy the remaining fruit buds and the crop is then lost.

Summer Pruning.

If summer pruning is practiced at all it must be done with the utmost care. About all that it is advisable to do is to thin out surplus shoots on young trees and head back vigorous leaders which tend to make trees unsymmetrical. Limbs that are cut during the growing season start growth from several buds thus forming bushy tops. Sometimes the error is made of trying to thin out the top by summer pruning and the result is a thick bushy top much less desirable than the original top.

The Cultivation and Cropping of Young Orchards.

Peach orchards should most certainly be thoroughly cultivated, but the methods will need to be modified in different parts of the state for a mountain orchard cannot be handled like an orchard on level land.

If the orchard is not to be cropped its management is very simple on level or somewhat rolling land. It should be plowed in spring as soon as the ground is in good plowing condition and be thoroughly harrowed to work the soil into good tilth. Every ten days or two weeks the harrow should be run over the ground to loosen it up unless a heavy rain has packed it down in the meantime, and then it should be harrowed as soon as dry enough. The point is to keep a fine loose dust mulch to prevent the evaporation of soil moisture.

This harrowing should be continued until about the first of August when as soon as weather conditions are favorable the cover crop seed should be sown. The commercial fertilizer should be applied and worked into the soil just before the cover crop seed is sown. In this way the cover crop gets the immediate effect of the fertilizer, and when this crop is plowed under the following spring it soon decays and makes available plant food for the trees. The cultivation for following years is about the same as mentioned for the first year.

In hilly or mountainous orchards this complete cultivation cannot safely be adopted on account of the danger of serious washing away of the soil unless furrows are plowed following the contour of the land to check the washing. It may be necessary to plow only strips eight or ten feet wide along the rows in spring and cultivate these until August when the middles may be plowed also and the fertilizer applied and cover crop seed sown. A cover crop used successfully in Western Maryland is a mixture of crimson and red clover. The crimson clover grows rapidly in spring and after it blooms and dies down on the unplowed middles the red clover takes its place, thus making a live cover until the ground is plowed in August in preparation for the fertilizer and cover crop seed.

It is a good practice to grow some early maturing hoed crop among the young trees until they begin to bear, but extra fertilizer or manure must be used for this crop so the trees will not be injured. Such crops as early potatoes, tomatoes, melons, sweet corn, and anything which is not late in maturing, are best, because late cultivation for late maturing crops may cause late growth on the trees and if this growth fails to ripen it may be winter killed.

After the trees are in good bearing the orchard ought not to be planted to any other crop, yet this is done successfully if intelligently practiced and plenty of fertilizer or manure is used.

The small grains like wheat, rye and oats should never be allowed to mature in the orchard because they require so much moisture of which they rob the trees.

COVER CROPS.

A cover crop is a covering of plants on the ground when the tree growth is not very active, or entirely dormant. The principal uses of a cover crop are as follows: to check the growth of trees in the fall and cause them to ripen their wood; to take up soluble plant food which might otherwise leach out into the drainage in late fall and early spring; to catch the rain and conduct it into the soil rather than to let it run over the surface and wash away the loose soil, and to hold the snow to further protect the soil; to protect the ground from deep freezing; to catch soluble plant food in early spring before root action begins in the trees; to pump the surplus water out of the ground in the early spring and thus help to warm it up; and to add vegetable matter to the soil. The cover crop must be plowed under in the spring before it dries out the soil enough to affect the trees.

The vegetable matter in the cover crop helps to improve the mechanical condition of the ground by loosening up the soil particles; by increasing the water holding power of the soil; by providing a favorable home for soil bacteria; by furnishing elements of plant food in available form; and by assisting in breaking up chemical compounds of plant food which might otherwise remain unavailable. Cover crop plants may be divided into three classes; the leguminous ones or nitrogen gatherers like the clovers, vetches, alfalfa, cowpea, soy bean, Canada pea and velvet bean; the potash plants like cowhorn turnip and rape; and ordinary plants like rye, oats, buckwheat and weeds.

The nitrogen gatherers are so named because special forms of soil bacteria associate with them and extract free nitrogen from the air and store it in tubercles on the plant roots. If a soil is deficient in nitrogen these bacteria form many tubercles on the roots of the plants, but if the soil is well supplied with nitrogen they form fewer tubercles on the roots. This class of plants also returns large amounts of potash and phosphoric acid to the soil.

The potash plants seem to be gross feeders and take up cruder forms of plant food than the more delicate nitrogen gatherers, but store up much nitrogen as well as potash and considerable phosphoric acid.

The other class of plants is useful when enough nitrogen is stored in the ground and a winter cover only is needed. The small grains should never be allowed to ripen in an orchard.

When to Sow the Seed.

Cover crop seed should be sowed early in August if weather conditions are favorable. The fertilizer should be applied when the ground is prepared for the cover crop seed. Small seeds like clover should be covered with a very light smoothing harrow or weeder and large seeds with a heavy harrow.

Unless there is moisture enough in the soil to germinate the seeds, sowing should be delayed until rain comes. Crimson clover especially will not germinate in a dry soil. Seeding in dry soil will probably result in failure.

Amount of Seed Per Acre.

The different clovers should be sowed at the rate of 12 to 20 pounds of seed per acre; hairy vetch 40 pounds per acre; cowpeas and soy beans 1 to 1½ bushels per acre; cowhorn turnips 1 to 2 pounds per acre, and dwarf Essex rape 8 to 10 pounds per acre. Combinations of various kinds may be made using one-half the amounts of seed just mentioned when two kinds are used together, one-third of each kind when three are used, etc. Crimson clover 15 pounds and cowhorn turnips 1 pound make one of the very best combinations.

Crimson clover is one of the best cover crops where it succeeds because it lives over winter and adds so much available plant food and vegetable matter to the soil. Cowpeas and soy beans are killed by the first hard frost. Hairy vetch and red clover are hardy. Rape and cowhorn turnips die down during the winter, but many of the roots send up seed stalks in spring.

If it is desired to have a summer cover crop, the best practice is to sow cowpeas in rows and cultivate them occasionally. The tops may be cut for hay and the stubble plowed under in August.

MANURE AND COMMERCIAL FERTILIZER.

Soils vary so much in type and from previous care, or lack of care, that it is quite impossible to prescribe the proper amount of fertilizing ingredients to give best results. The poverty or richness of the soil must determine the amount of fertility to be added. Well rotted manure in generous amounts up to twenty to thirty tons per acre is always desirable and beneficial unless the trees are making a rank growth.

The commercial fertilizer formula per acre given here is suggested as being a good one for a bearing orchard on ground of medium fertility; for poor soils the amount should be increased and for rich ones diminished:

150 pounds nitrate of soda.
150 pounds dried blood.
150 pounds acid phosphate.
150 pounds sulphate of potash.

This formula is 6 per cent. nitrogen, 3½ per cent. phosphoric acid and 12½ per cent. potash. Other kinds of fertilizers than those given above may be used, but the percentage of plant food ought to be about that just given.

The idea that fertilizer may be used to produce high color on the fruit is not borne out by experiment. Sunlight admitted by proper pruning is the best coloring agent.

OLD AND NEGLECTED ORCHARDS.

There are neglected orchards which might be reclaimed and made profitable with proper pruning, spraying, fertilizing and cultivating. All dead wood, stubs, and crowding branches, should be taken out and the leaders or main branches should be headed back. If the trunks are in good shape and the tops are weak, the trees might better be stub pruned (see figure 22) so as to grow new tops. This is thoroughly practicable and will lengthen the life of the orchard several years. If it is desired to change the variety this may be easily done by budding a few of the new shoots to the variety wanted. A thorough spraying with lime-sulphur like that mentioned later on for San Jose scale should be applied in March. This will kill disease germs and many insects and rid the trees of moss and lichens. Tree borers should be looked after at the proper time as mentioned on page .... An application of 150 pounds of nitrate of soda, 175 of dissolved rock and 125 of sulphate of potash per acre to stimulate growth should be spread broadcast just before the ground is plowed in spring. Harrowing should be started at once and be continued about every ten days or two weeks to keep the soil mellow and in good tilth.

Spraying to control insects and diseases should be done as mentioned on pages 187-191.

THINNING THE FRUIT.

If there is a heavy set of fruit left after the "June drop" it should be thinned so that the fruits left are as evenly distributed as possible over the entire tree and average from four to six inchs apart on the bearing wood. Thinning should be done just before the pits begin to harden when the fruits are about three-fourths of an inch in diameter It is the maturing of the pits which exhausts the vitality of the tree and the ripening of pits in excess of a good crop is a useless strain on the tree. Thinned fruit is larger and usually better colored and flavored than unthinned fruit, and the yield is just as large in bulk and sells at a higher price. The fruit must all be picked some time and the surplus is quicker and easier removed at thinning time than at harvesting time. Moreover, the little fruits are of some value as fertilizer. The average cost of thinning is about ten cents per tree.

ORCHARD HEATING.

Late spring frosts cut the crop short in some parts of the state every year and are one of the leading factors in reducing the profits of peach growing. Orchard heating must be practiced if growers will do their part toward producing annual crops. At first thought this seems to be almost an impossibility, but it is not difficult, although it means work and loss of sleep when frost threatens.

The necessary equipment consists of several ordinary thermometers, an alarm thermometer, some means of distributing fuel to the heaters. storage tanks for oil, machine waste for wicks in new heaters, 200 gallons of oil per acre, and from 80 to 100 heaters per acre.

The alarm thermometer is placed in the orchard and is connected by telephone wires to an alarm bell in the house, enough electric batteries being attached to ring the bell when the mercury drops below a certain point, usually 30 degrees F. The other thermometers should be distributed throughout the orchard and one or two outside the heated area, so as to compare the temperature inside and outside the heated area. If the temperature drops to 30 degrees F. a short time before sunrise, it will most likely not be necessary to light the heaters. If the thermometer reaches 30 degrees during the night, and is likely to go lower. then every fourth or every second heater at least should be lighted at once to keep the temperature above the danger point. 30 degrees F. By comparing the thermometers inside and outside of the orchard, the attendant can tell whether a portion or all of the heaters should be lighted. After the coldest point is reached and the atmosphere begins to warm up, a few of the fires can be extinguished As it becomes warmer, more and more fires are dispensed with until finally all are extinguished.

Heaters should be placed in the squares between the trees rather than under the trees, with a double row along the windward side. About 100 of the small heaters 7 to 9 inches in diameter are required per acre, and only 80 of the larger ones 12 to 14 inches across. These may be purchased from various manufacturers or be made by the local tinsmith. A good grade of stove-pipe sheet iron is used. It is well to have the bottom smaller than the top so they will nest and thus be easily stored or shipped. A convenient size is 8½ inches across the bottom, 9½ inches across the top and 12 inches high. This size will hold three gallons of crude or fuel oil and burn about one quart per hour. Metal paint pots in which white lead is shipped are as good as any type of oil heater, and may usually be obtained from paint stores. Every heater must have a cover to keep out rain and snow.

In our work at the Experiment Station in 1910 and 1911 the oil heaters were much more satisfactory than the coal heaters because they are easier and quicker lighted, they throw out the maximum amount of heat at once and burn steadily, they are instantly extinguished bv placing the cover on, and there is no waste of fuel. New heaters are often difficult to light up unless a wick of machine waste or a few drops of gasoline are used. Torches are manufactured with a gasoline attachment by means of which a few drops are discharged on the oil just before the torch is applied. After being used a time or two they light up much more easily. As near as we can estimate at present the maximum amount of crude or fuel oil which might be necessary per acre per season is 200 gallons. Any unused oil is stored for future use.

In an efficiency test where the outside temperature was 30 degrees F. we found that 100 oil heaters per acre raised the temperature to 40 degrees and 100 coal heaters per acre raised the temperature to 36 degrees in two hours.

Harvesting.

For distant shipment the fruit must be picked while still firm, but should be fully grown and well colored. The grower must endeavor to have it reach the market just as it is in condition to use. For local marketing it may be allowed to begin to ripen on the trees.

The fruit must be handled carefully for bruised portions, discolor and rot. The swing handle, splint half-bushel baskets are about the best picking baskets to use and are sometimes padded. Very often the Delaware peach baskets are used for picking baskets.

The fruit should be hauled in spring wagons from the orchard to the packing houses.

Packing Table.

The packing table shown in figure 26 is a good type and will accommodate three packers. This may be made in any size and shape.

The bottom is of canvas or burlap and slopes toward the side where the packer stands.

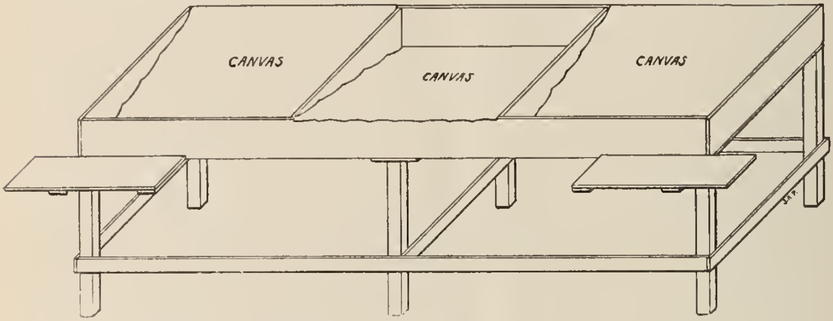


Fig. 26—Packing table (fig. 19, Bulletin 116, page 241).

GRADING AND PACKING.

The fruit should be carefully graded, putting only the largest, well colored and unblemished fruit in the first grade. This should be wrapped in neat paper wrappers on which is printed the name of the grower, his guarantee of good fruit and the name of his fruit farm.

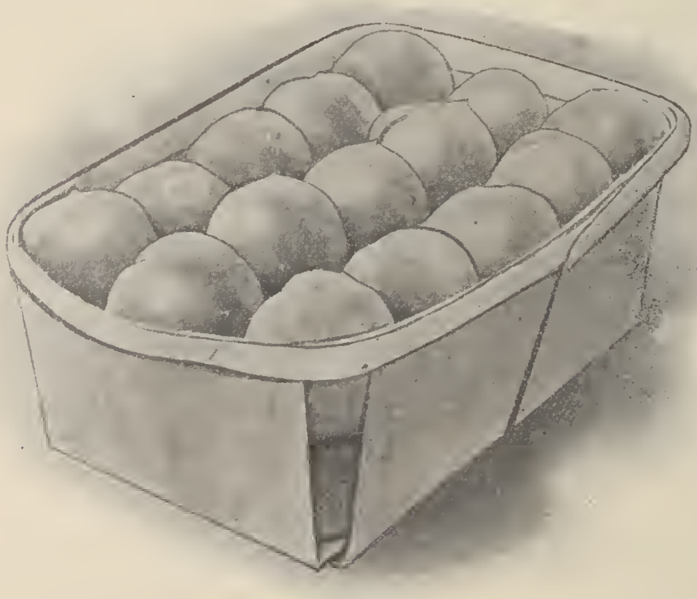


Fig. 27—The square pack in a Georgia carrier basket (fig. 17, Bulletin 116, page 239).

The medium sized fruits of the same quality should make up the second grade. These two grades should be packed in the six basket carriers known as Georgia carriers. The best of the remaining fruit should be packed in the 4/8 or 5/8 bushel basket, but even this third grade should not contain cull stock.

The proper placing of peaches in the carrier baskets makes all the difference between a good pack and a poor one and between a good price and a moderate price for fruit of the same grade. Figure 27 shows a basket of good peaches apparently well packed, but when fruit so arranged in two tiers, one squarely on top of the other, reaches the market, it will have settled below the top of the basket and it will look like a slack pack. The same fruit in the "diamond pack" as described in the following paragraphs will reach the market in good condition, present a full package, and sell at the top price. This diamond pack requires no more fruit per basket than the other, but it brings more money.

The general principle of the diamond pack is that no peach rests directly on top of any other peach, but rather above and between two other fruits, or one fruit and the side of the basket.

The number of fruits per basket in this pack depends upon their size, but the general scheme of arranging them is the same and the tip ends should all point the same direction. Figure 28 shows that with medium sized fruit the first row across the basket in the bottom tier has two fruits, the second row has two, alternating with the first two, the third row has two alternating with the second, and the fourth and fifth rows alternate similarly. The fruits in the middle tier alternate with those of the bottom tier and those in the top tier alternate with the middle tier, being exactly above the bottom tier. The end of a basket shows how the middle tier is placed above the bottom one and the top tier above the middle one. This pack requires 30 peaches the same as the square pack shown in figure 27.

With large fruits it requires only two layers to fill a basket instead of three. The size will determine the number of tiers and how the fruits must be arranged in the basket.

The very large fruits are arranged with two in the first row, one in the second, two in the third, one in the fourth and two in the fifth, two tiers filling the basket, as shown in figure 29. The second tier alternates with the first tier with one peach in the first row, two in the second and so on. Fruit just above medium size will pack this way, 2 x 1, with three tiers to the basket.

If the fruit is too small to pack 2 x 2 as shown in figure 28, it should be packed 3 x 2 as shown in figure 30.

For protecting fancy fruit packed by the three tier diamond method, a padded and stripped partition and cover should be used because the fruit projects above the top of the baskets and will be badly bruised with the ordinary partition and cover.

Another method of arrangement is to have three peaches in each row in the bottom layer, two in each row in the middle layer alternating with the first layer, and three in each row in the top layer alternating

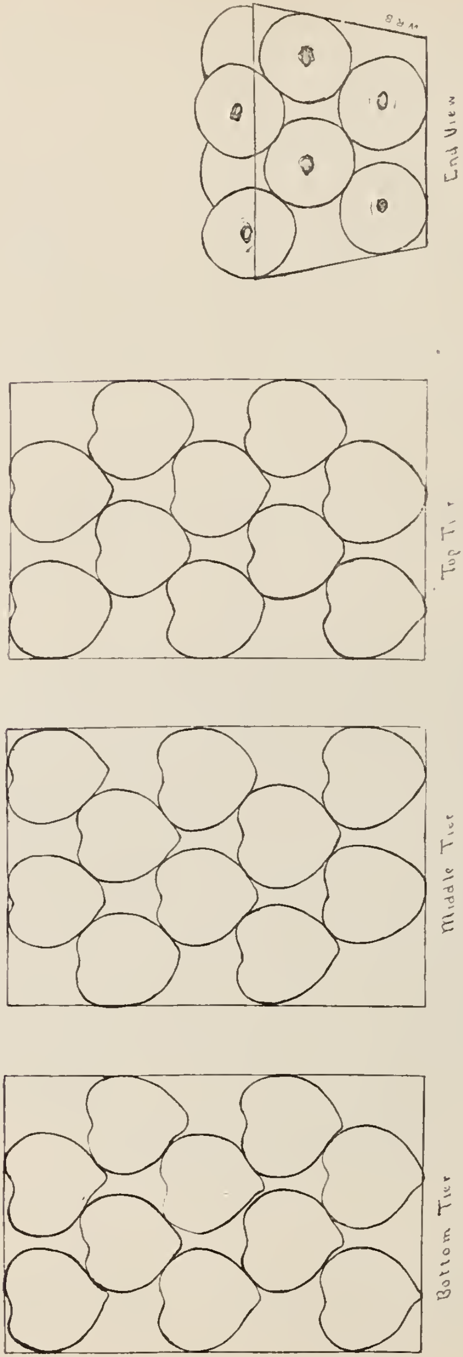


Fig. 28—The 2x2, three tier, diamond pack in the baskets of the Georgia carrier. (Drawing by W. R. Ballard).

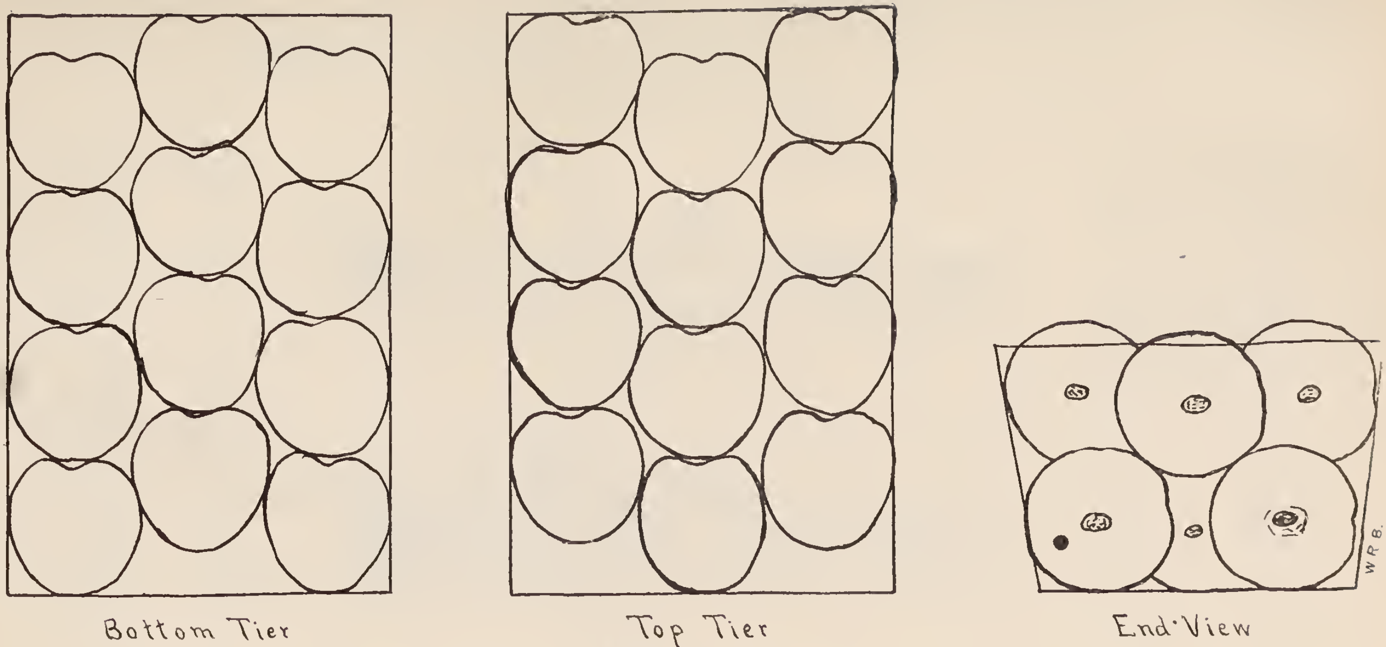


Fig. 29—The 2x1, two tier, diamond pack in the baskets of the Georgia carrier. (Drawing by W. R. Ballard).

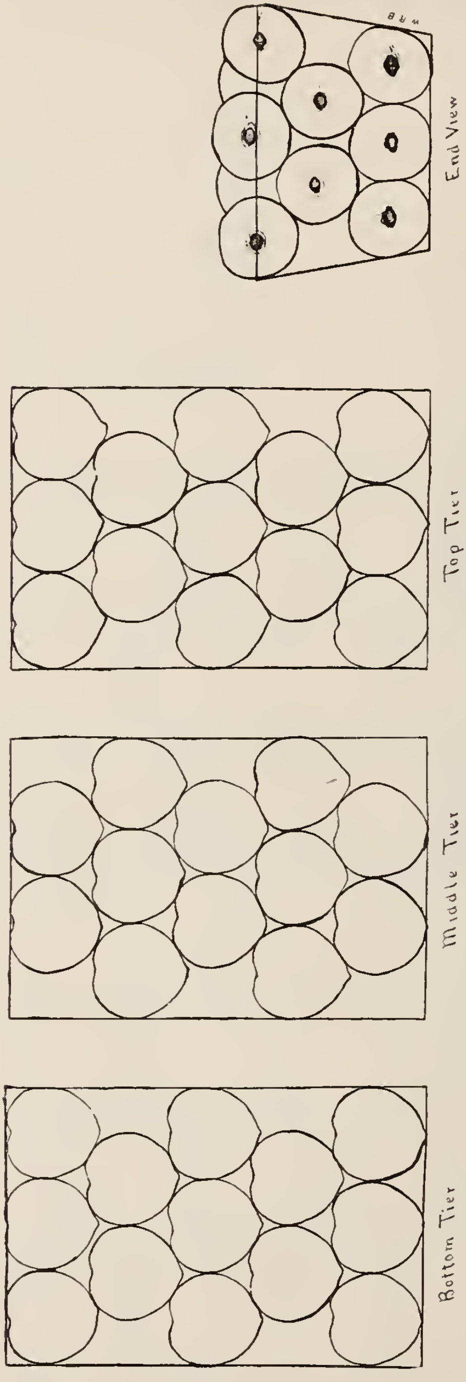


Fig. 30.—The 3x2, three tier, diamond pack in the baskets of the Georgia carrier (Drawing by W. R. Ballard).

with the middle layer. By this method one peach does not set squarely above another.

The fruit shipped in 4/8 or 5/8 bushel baskets should be of the same grade from top to bottom and be firmly packed so as not to settle much or shake around and become bruised before reaching the market.

Propagation.

The peach is propagated by budding on seedlings of the first year's growth. The pits are either planted in nursery rows four feet apart in the fall, or are stratified with earth during the winter and planted in the spring. The seedlings should stand 6 or 8 inches apart for ease in budding. Shield budding is the method used as shown in figure 31. Budding is done whenever the bark slips in June and August or September. The vagaries of the season may influence the time somewhat.

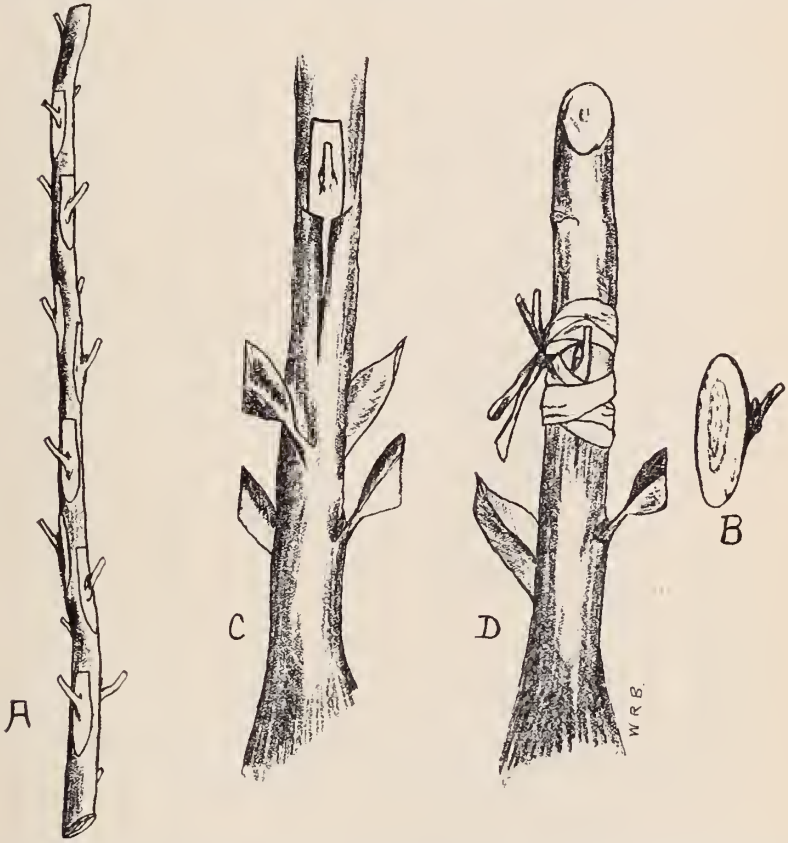


Fig. 31—Budding the peach. (A)—A bud stick showing how to cut the buds. (B)—A bud cut off—much enlarged. (C)—The T-shaped cut made in the seedling stock and the bud being inserted. (D)—The bud inserted and wrapped with raffia. (Drawing by W. R. Ballard).

The buds used are taken from growing twigs preferably from healthy trees bearing good crops of fine fruit of high quality and color. As soon as the twigs are cut the leaves are removed leaving half an inch of the leaf stalk, and the twigs or "bud sticks" are wrapped in moist paper or cloth to prevent drying out.

Shield budding is done as follows: A T-shaped cut in the bark of the stock is made where it is desired to place the bud. The bud stick is taken in the left hand with the butt pointing downward or outward, and a cut is started half an inch below the bud running the knife beneath it and half an inch above. The leaf stalk serves as a handle for placing the bud into the T-shaped cut on the stock after which it is wrapped tightly with moist raffia or coarse, soft cord; figure 31 shows the way to proceed. In about 10 days the budding wound will heal and the raffia or cord wrapper should be cut on the side opposite the bud. If fall buding is done the seedlings are not disturbed until early the next spring, but the tops must then be cut off about three-fourths of an inch above the bud so it will be forced into rapid growth.

If June budding is practiced, a few inches of the tips of the seedlings must be cut off as soon as the buds are inserted. When the buds begin growth the entire seedling top should be removed at once.

The source of the best peach seed is open to a wide range of opinion. The small pits from seedling trees on the mountains of some of the southern states are considered by many nurserymen to be the best, because it is supposed that peach yellows does not exist there. However, peach yellows is prevalent in some sections of those mountains. The pits from named varieties are used in large amounts and are obtained at canning factories.

Races or Types of Peaches.

The peach originated in central and southern Asia, and is divided into five botanical races, namely:

North China race.
South " "
Peen-To "
Spanish "
Persian "

The North China race is rather large, roundish lopsided oval, with large obovate pointed pit. To this race belong these varieties: Becquett Free, Chinese Cling, Elberta, Family Favorite, General Lee, Mamie Ross, Smock and others.

The South China race is medium sized, lop-sided oval with long drawn out projecting tip. The pit is of the same shape. This race is not commonly cultivated but is represented by Climax, Early China and Honey.

The Peen-To race is of a flat tomato shape, seldom cultivated except in the Southern States. There are twenty or more varieties, among which are Bidwell Early, Jewell, Maggie, Peen-To and Suber.

The Spanish race is medium size, lopsided oval with blunt point and large roundish oblong pit with small tip. A few varieties are Cobler, Columbia, Galveston, Texas and Victoria.

The Persian race is globular in shape and is the parent of many of our cultivated varieties like Alexander, Amsdem, Early Rivers, Crawford Late, Foster, Heath Cling, Old Mixon Cling, and Old Mixon Free.

There are a few unclassified varieties like Bilyeu, Beer Smock, Sneed, Stump and others.

Recommending Varieties

The peach is to a considerable extent particular as to its environment and all varieties will not succeed in all localities, hence it is not good practice to recommend varieties for commercial use in any section unless they have been tested to prove their adaptability in that section. We are constantly meeting with surprises in the behavior of many varieties; some succeed admirably on soils and in local weather conditions which are apparently not suited to the peach, and, on the other hand, they do not always prove satisfactory under apparently favorable conditions. The Elberta is cosmopolitan and is the leader nearly everywhere. In central and southern Maryland and on the Eastern Shore the Mountain Rose, Early Rivers, Carman, Champion, Reeves, Elberta, Crawford Late, Chairs, and Fox usually do well. In Washington county this list is increased by Smock, Salway, Bilyeu and some of the newer kinds. We urge that fruit growers test the most promising of the new varieties as they are introduced. This can be done with three or four trees and nurserymen may be willing to donate a few trees for this special purpose.

Acknowledgment.

It is with the utmost pleasure that we acknowledge our indebtedness to Col. G. B. Brackett, Prof. L. C. Corbett and Mr. E. C. Butterfield for so kindly sending us fruit of scores of varieties, and for extending to us the freedom of the orchards on the Government Experimental Farm at Arlington, Va., that we might study and describe the various varieties as they ripened. These gentlemen most courteously shared their knowledge and records of the different varieties with us, and we cheerfully give them and the departments they represent full credit for all they have done. Nearly all of the descriptions of varieties which follow were made from fruits grown at Arlington Farm. It was a rare opportunity to study the behavior of two hundred varieties of peaches in one orchard.

Descriptions of Varieties.

Among the many varieties described in this bulletin we call especial attention to the following ones and request that they be tested throughout the state for we believe they are worthy of a place in home and commercial orchards wherever they are adapted to the existing local conditions:

Yellow flesh, free stone.

Ameliaberta.
Christiana.
Gold Miller.
Emperor.
Frances.
Grady.
Late Elberta.
Mountain Rareripe.
Reed's Late Barnard.
Scott.
Turner.
Wright Nebraska.
Barber.
Crosby.
Dover.
Fitzgerald.
Frederica.
Heidelberg.
Marshall.
Persis.
Ring.
Smith Yellow.
Ward.
Beers Late.
Crothers Late.
Edgemont.
Foster.
Garfield.
Worthen (Jennie).
McCollister.
Lyon.
Ruding.
Slappy.
Worcester.

Yellow flesh, cling stone.

Downer.
Red Bird Cling.

Yellow flesh, semi-cling stone.

Pickett Late.
Susquehanna.

White flesh, free stone.

Arp (Beauty).
Early Michigan.
Heath Free.
Delaware.
Klondyke.
Grosse Mignonne.
Switzerland.

White flesh, semi-cling stone.

Bowers (Early).

Allen.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, roundish-oblong, medium size; suture beyond apex, shallow except at apex; apex rounded; color greenish white mottled and marbled with red, rather attractive; skin moderately thick, rather tough, downy; stone free, rather large, oval, thick; flesh white, red at stone, juicy, meaty; flavor mild pleasant subacid, nearly sweet; quality fair; season August 12 to 22 in 1910.

Ameliaberta (Amelia Berta).—Tree spreading, vigorous, stocky; bark a little rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands reniform; fruit uniform, roundish-oblong, sides unequal and lopsided, medium to very large; suture to apex, a line; apex a minute point, rounded; color very attractive, rich yellow with heavy rich red blush and mottling; skin thick, tough, downy; flesh yellow, red at pit, juicy, fibrous, meaty; stone free, large, obovate-roundish with point, thick, pitted; flavor pleasant subacid, nearly sweet, spicy; quality good; apparently an excellent market sort; season August 14 to 25 in 1910.

Arkansas,—Tree somewhat spreading, vigorous, stocky; bark smooth, bright, twigs green; foliage abundant, healthy, dark green; leaf large, long, narrow, crinkled, finely serrated, glands orbicular; fruit uniform, roundish, sometimes restricted toward base, sides often unequal, medium size; suture to apex, moderately deep; apex rounded; color creamy white, bright light and dark red mottling and purple patches; skin thin, tough, very downy; stone semi-cling, medium thick, long obovate, finely pitted; flesh pale greenish or yellowish white, tinged with red, melting; flavor pleasant subacid, nearly sweet; quality fair; season June 26 to July 7 in 1910.

Arp (Beauty),—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands reniform; fruit medium size, roundish, lopsided, slightly oblong, flattened toward apex; suture to apex, a line; apex rounded; color pale yellow with dull or bright blush, moderately attractive; skin nearly smooth, thin, tough; flesh white, red at stone, melting, juicy, fibrous; flavor nearly sweet, pleasant; quality fair; stone free, large, long oblong, short point, rather flat; season August 6 to 22 in 1910.

Bailey,—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf variable from medium to large, finely serrated, crinkled, glands reniform; fruit uniform, roundish, flattened at base, sides often unequal, small to medium; suture to apex shallow; apex rounded; color pale yellow with rich red mottling and scarlet patches; skin thin, somewhat tender, downy; flesh rich yellow, red at stone, rather dry; flavor sweet, rather flat; stone free, medium, nearly round, consideragle point, thick, pitted moderately fine; quality fair; season September 3 to 13 in 1910.

Banner,—Tree erect, vigorous, stocky; bark nearly smooth, dull, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, narrow to broad; crinkled, serrated, glands reniform; fruit uniform, free from disease, roundish, medium to large; suture to apex, deep or shallow; apex roundish with minute point; color pale yellow mostly washed and mottled with bright red, rather attractive; skin thick, tough, downy; stone free, large, roundish, very thick, coarsely pitted; flesh yellow, tinted red, red at stone, dry or moderately juicy, meaty; flavor nearly sweet, not much character; quality fair; season August 29 to September 2 in 1910.

Barber,—Tree spreading, moderately vigorous; bark rough, dark, twigs bright; foliage abundant, little disease, dark green; leaf long, narrow to broad, serrated, smooth, glands orbicular and reniform, abundant; fruit uniform, medium to large, roundish, sides unequal, considerable rot; suture to apex, shallow; apex a small point; color very attractive rich yellow almost entirely covered with light and dark red; skin thick, tender; stone free, medium size, elliptical with small point, thick, smoothly pitted; flesh rich yellow, red at stone, melting, fibrous, meaty; flavor nearly sweet, spicy, rich, pleasant; quality extra good; very desirable; season August 12 to 22 in 1910.

Beall Late White,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, sharply serrated, glands orbicular; fruit uniform, roundish, compressed at base opposite suture side, sides unequal, large; suture to apex or beyond, moderately deep; apex rounded with small depressed point; color pale greenish yellow mottled and blushed with thin bright red, not very attractive; skin thick, tough, downy; flesh creamy white stained red, red at stone, moderately juicy, fibrous, very meaty; stone free, broadly elliptical to roundish lopsided with large heavy keel, thick, coarsely pitted; flavor mild subacid; quality good; ripened October 8 in 1910.

Barnard.—Fruit uniform, roundish, medium to above; suture beyond apex, shallow; apex rounded with small point; color rich yellow, mottled with bright red and blushed with heavy dark red, very attactive; skin thick, tough, downy; flesh rich yellow tinged with red, red at stone, juicy, fine, meaty; stone free, roundish with point; flavor mild subacid, slightly bitterish; quality good; ripened August 19 in 1907.

Beauty B.,—Tree erect, spreading, vigorous, stocky; bark rough, dull, twigs green; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands orbicular or reniform; fruit roundish, sides flattened toward apex, moderately large; suture to apex, a line; apex rounded; color rich yellow with bright blush, attractive; skin thick, tough, downy; flesh yellow, red at stone, juicy, meaty; stone free, large, obovate, lopsided, thick; flavor pleasant mild subacid, spicy; quality good; season August 6 to 15 in 1910.

Beers Late.—Tree somewhat spreading, vigorous, stocky; bark rough, dark, twigs bright; foliage abundant, healthy, dark green; leaf crinkled, medium to large, long, wide, finely serrated, glands orbicular; fruit uniform, roundish, flattened and tapering on sides to apex, sides unequal, large to very large; suture to apex, shallow; apex rounded, often a small tip; color rich dark yellow with rich mottling over most of skin, very attractive and rich in appearance; skin thin, rather tough with considerable down; flesh yellow, melting, juicy, somewhat fibrous, meaty, red at stone; stone free, large, nearly round, lopsided, thick, coarsely pitted, rough; flavor nearly sweet with a trace of subacid, rich, pleasant; quality excellent; ripened September 5 in 1911. Expect this to be a good commercial variety.

Belle (of Georgia).—Tree spreading, very vigorous, stocky; bark moderately smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands reniform; fruit uniform, roundish, slightly flattened, sides unequal, medium size; suture to apex, shallow; apex a minute point; color pale yellow with bright red blush; skin thick, tender, downy; stone free, large, ovate, pointed; flesh white, much tinted with red, red at stone, juicy, fine, meaty; flavor pleasant subacid; quality good; ripened August 19 in 1907.

Berenice (Burnice).—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands reniform; fruit uniform, roundish, sides unequal, somewhat bulged on suture side, lopsided, small to medium; suture to apex, a line; apex roundish, a minute point; color pale yellow with small thin blush; skin thin, tough, downy; stone free, large, obovate with point, thick; flesh rich yellow, red at stone; flavor mild subacid, nearly sweet; quality fair; ripened August 25 in 1910.

Bilyeu.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, somewhat crinkled, finely serrated, glands orbicular; fruit uniform, roundish, sides unequal, large; suture to apex or beyond, moderately deep; apex rounded with small point; color creamy white with a purplish red blush; skin moderately thick, tough downy; flesh white, red at stone, moderately juicy, meaty; stone free, very large, oval, thick, coarsely pitted; flavor subacid, slightly bitterish; quality good; ripened October 13 in 1910.

Bokhara.—Tree spreading, vigorous, stocky, not diseased; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands both orbicular and reniform; fruit uniform, roundish, pointed at apex, small to medium; suture to apex, a line; apex pointed; color greenish with dull blush; skin thin, moderately tough, slightly downy; stone free, large, oblong with long point, flat; flesh greenish-white, red at stone, rather dry, meaty; flavor subacid, flat, quality poor to only fair; season July 31 to August 12 in 1910.

Bonanza.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, narrow to broad, very finely serrated, crinkled, glands reniform; fruit uniform, nearly obovate, much constricted toward apex, medium size; suture beyond apex, shallow to deep; apex a small point; color very pale yellow with a small thin, bright blush; skin thick, tender, short down; flesh white, red at stone, juicy, fibrous, meaty; stone free, very large, long obovate with small point, thin at base, thick toward apex, coarsely pitted; flavor mild subacid; quality fair; season September 9 to 23 in 1910.

Bowers (Early),—Tree erect and spreading, vigorous, stocky; bark rough, bright, twigs green; foliage abundant, healthy, dark green; leaf large, long, wide, coarsely serrated, glands reniform; fruit uniform, roundish, flattened at ends, sides often unequal, moderately large; suture to apex, moderately deep; apex rounded; color white with bright light and heavy red mottling with purple blush, very attractive; skin thin, moderately tender, slightly downy; stone semi-cling to cling, small to medium, obovate, thick, smoothly pitted, pointed; flesh greenish white, melting, juciy; flavor rich, sweet, very pleasant; quality good; season July 2 to 11 in 1910.

Brackett Cling,—Tree spreading, vigorous, stocky; bark rough, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf large, long, broad, serrated, glands reniform; fruit uniform, free from disease, roundish, small tip, sides unequal, moderately large; suture to apex, a line; apex a small point; color dull yellow with bright red blush and mottling; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, meaty; stone cling, large, oblong with point, thick, smoothly pitted; flavor pleasant, spicy; quality good; season August 30 to September 9 in 1910.

Briggs May (Red),—Tree spreading, vigorous, stocky; bark moderately smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium size, long, moderately wide, coarsely serrated, glands wanting; fruit uniform, roundish, sides often unequal, very slightly flattened, medium; suture to apex, moderately deep; apex rounded; color creamy-white with bright red mottling and carmine splashes, very attactive; skin thin, rather tough, slightly downy; flesh creamy slightly tinged with red; melting, moderately juicy, somewhat fibrous; stone cling, medium, obovate with point, thick, smoothly pitted; flavor mild subacid; quality fair; season June 26 to July 8 in 1910.

Brunson,—Tree spreading, vigorous, stocky; bark nearly smooth, dark, twigs bright; foliage abundant, healthy, light green; leaf medium to large, long, narrow to broad, serrated, glands reniform; fruit uniform, roundish, small, sides often unequal; suture to apex, a line; apex rounded with minute point; color pale yellow with small heavy blush; skin rather thick, tough, downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, almost round with long point, thick, finely pitted; flavor pleasant subacid, nearly sweet, spicy; quality excellent; not enough color for good market sort; season August 15 to 26 in 1910.

Burk,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium size, moderately long, wide, sharply serrated, glands orbicular; fruit uniform, roundish, sides often unequal, medium size; suture to apex, deep at apex only; apex rounded; color creamy mottled with rich red over most of surface; skin thick, tough with considerable down; flesh creamy, tinted red, red at stone, moderately juicy; stone free, medium size, obovate with short point, thick, finely pitted; flavor nearly sweet with tinge of subacid; quality fair; ripened September 13 in 1911.

Butler.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf medium to large, long, narrow to wide, finely serrated, glands reniform; fruit uniform, practically free from disease, round, sides often unequal, sometimes lopsided, flattened at ends, medium large; suture to apex, shallow or deep; apex pointed or rounded; color rich yellow with heavy blush and bright red mottling; skin thick, tough, downy; flesh rich yellow, tinged with red, red at stone, juicy; stone cling, large, broad, elliptical with small point, very thick, finely pitted; flavor pleasant, nearly sweet; quality fair; productive and attractive; season September 9 to 13 in 1910.

Canada.—Tree erect, spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium, moderately long, mostly narrow, coarsely serrated, glands orbicular; fruit uniform, roundish, sometimes flattened at ends, sides often unequal, medium size; suture to apex, moderately deep, apex rounded; color creamy white almost covered with heavy dark red, with broken stripes and mottling, very attractive; skin thick, tender, downy; flesh greenish white slightly tinged with red, becomes mushy as it ripens, melting, juicy, fine grained; stone free to semi-cling, medium large, roundish with point, very thick, deeply pitted; flavor mild pleasant subacid, rather flat, quality fair; season June 26 to July 11 in 1910.

Carman.—Tree erect, vigorous, stocky; bark moderately smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, glands reniform; fruit uniform, considerable rot, free from insects, roundish to roundish slightly flattened, sides unequal, large to very large; suture to apex, shallow; apex rounded; color yellowish white with heavy dark red blush over one-half of fruit, slightly mottled; skin thick, tough, slightly downy; stone free, very large, roundish oblong, pointed; flesh yellowish white, juicy, moderately fine, fibrous, very meaty; flavor pleasant, spicy, good; ripened August 1 in 1911.

Carpenter (Cling).—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, rather wide, serrated, glands orbicular; fruit uniform, roundish oblong, sides somewhat unequal, medium size; suture to apex, a line; apex rounded with minute point; color pale yellow with thin mottled blush; skin thick, tough downy; stone cling, large, elliptical with long point, thick; flesh creamy yellow, juicy, meaty; flavor mild subacid, nearly sweet; quality good; season August 21 to 30 in 1910.

Chairs.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, health, dark green; leaf large, long, broad, finely serrated, crinkly, glands orbicular; fruit uniform, medium to large, globular with slight tip; suture beyond apex, shallow; apex a small point; color rich yellow blushed, mottled and splashed with dark crimson; skin medium thick, rather tough, slightly downy; flesh rich yellow, red at pit, tender, melting, juicy; flavor rich mild subacid; quality excellent; pit medium size, free, oval, thick; season last half of August.

Champion.—Tree erect, vigorous, stocky; bark rather rough, color dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, round, flattened at base, medium large; suture to apex, shallow; apex rounded; color dull yellow with dull blush; skin moderately thick, tough, downy; flesh rich white, red at stone, melting, juicy, fibrous; stone free, large obovate with point, thick, coarsely pitted; flavor sweet pleasant, spicy; quality excellent; season August 13 to 19 in 1910.

Chili (Hill's).—Tree spreading, moderately vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, moderately healthy, light green; leaf small to medium, long, narrow, finely serrated, glands reniform; fruit uniform, large, roundish oval, sides often compressed, halves usually unequal; suture to apex, shallow; apex rounded with minute point; color rich yellow, almost entirely washed with rich dark red, dark purple patches near cavity, dull colored; skin thick, tough, very downy; flesh very rich yellow, moderately juicy, fine, meaty; stone free, very large, elliptical, with considerable point, thick on suture side, but thin on opposite side, coarsely pitted; flavor vinous; quality good; ripened September 13 in 1911.

Chilow.—Tree erect, spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf small to medium, long, narrow to sometimes broad, serrated, glands reniform; fruit uniform, large, somewhat diseased, short oblong, bulged on suture side, sides often unequal, side opposite suture flattened; suture to apex, a line; apex rounded with minute point; color pale yellow with bright blush; skin nearly smooth, thin, tough; flesh yellow, red at stone, moderately juicy meaty; stone cling, oblong with small point, thick, smoothly pitted; flavor nearly sweet, spicy; quality good; season August 21 to 25 in 1910.

Chinese Cling.—Tree spreading, vigorous, stocky; bark moderately smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands reniform; fruit uniform, large, roundish or roundish-conic, sides unequal, slightly flattened; suture beyond apex, deep especially at apex; apex rounded; color pale yellow with thin light and dark red mottling and blush; skin thin, tough, downy; flesh white, slightly tinted red, red at stone, melting, juicy, slightly fibrous; stone cling, large, oval, thick; flavor mild subacid, sweet; quality fair to good; season July 19 to 29 in 1910.

Christiana.—Tree erect, vigorous, stocky; bark smooth, bright, twigs, bright; foliage abundant, healthy, dark green, crinkled; leaf large, long, narrow to wide, finely serrated, glands orbicular; fruit uniform, round, a little lopsided and sides often unequal, medium large; suture to apex, very shallow; color rich yellow, shaded, and mottled with rich dark red; skin thick, rather tough; downy; flesh rich yellow, red at stone, juicy, fibrous; stone free, large, obovate, one edge slightly undeveloped, thick, coarsely pitted; flavor rich, nearly sweet, spicy; quality excellent; especially attractive and productive sort, ought to be a good market peach; season September 1 to 10 in 1910.

Columbia.—Tree erect, vigorous, stocky; bark nearly smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, narrow to broad, finely serrated, glands reniform, crinkled; fruit uniform, round, sides unequal, a little flattened at ends, medium large; suture to apex, shallow; apex rounded; color yellow, entirely covered with red with dark scarlet markings; skin rather thin, tough, heavy down giving silvery appearance; flesh rich yellow at pit but just beneath skin is same color as skin only brighter, melting, juicy, fibrous; stone free, small, nearly round with point, one side undeveloped, thick, finely pitted; flavor nearly sweet, vinous; quality good; season August 31 to September 13 in 1910.

Conkling.—Tree erect, spreading, moderately vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf moderately large, long, narrow to wide, serrated, glands orbicular; fruit uniform, roundish, lopsided, flattened, suture side bulged, above medium size; suture to apex, shallow; apex pointed; color rich yellow blushed and mottled with dull dark red over one-half of fruit; skin thick, tough, somewhat downy; flesh light yellow, red at stone, juicy, meaty, slightly fibrous; stone free, large, obovate with point, thick; flavor mild subacid, pleasant, quality fair; season August 2 to 15 in 1910.

Connecticut.—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, light green; leaf large, long, rather narrow, serrated, glands orbicular or reniform; fruit uniform, roundish, slightly pointed, large; suture to apex, a line; apex a small point; color yellow mottled with dull red over nearly the entire surface, rather attractive; skin thick, tender, downy; flesh rich yellow, tinged with red, red at stone, moderately juicy, fine, meaty; stone free, large, irregular, thick; flavor pleasant, spicy, nearly sweet; quality good; ripened August 10 in 1910.

Connett (So. Ea.).—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, glands reniform; fruit oblong, flattened at sides, sides often unequal, Elberta shape, moderately large; suture to apex, shallow; apex slightly pointed or rounded; color white with thin blush; skin thick, tough, slightly downy; flesh white, red at stone, juicy, meaty; stone semi-cling, large, elliptical with point, moderately thick, smoothly pitted; flavor nearly sweet, spicy; quality good; season July 31 to August 9 in 1910.

Coolidge (Favorite).—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf large, long, moderately wide, serrated, glands orbicular; fruit roundish, flattened at ends, small to medium size; suture to apex, shallow; apex rounded; color pale yellow with rich light and dark red; skin thick, tough, somewhat downy; flesh white, red at stone, melting, juicy, meaty; stone cling, large, roundish with point; flavor sweet, spicy; quality fair; season August 3 to 10 in 1910.

Crockett ('s Late White),—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf large, long, broad, finely serrated, glands reniform; fruit uniform, free from disease, roundish, sides often unequal, medium size; suture to apex, a line; apex rounded with small point; color very pale yellow with small bright blush; skin thick, tough, downy; flesh white, slightly tinted at stone, moderately juicy, fibrous; stone free, small, elliptical with small point, thick; flavor vinous, nearly sweet; quality good; season September 8 to 23 in 1910.

Crosby,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, rather broad, serrated, glands reniform; fruit uniform, roundish, some are quite oblate, sides unequal, flattened at base and apex, large to very large; suture beyond apex, deep; apex rounded with slight tip; color pale yellow with rich blush and mottling of red; skin thin, tender, downy; flesh rich yellow, red at stone, melting, juicy, fine, meaty; stone free, medium size, oblong, lopsided, thick; flavor nearly sweet spicy, vinous; quality excellent; ripened September 10 in 1907.

Crothers Late.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, rather crinkled, serrated, glands reniform; fruit uniform, roundish, a little long, tapering slightly to apex, Elberta shape, large; suture to apex, a line; apex a small point, rounded; color rich yellow, with bright blush, very attractive; skin thick, tough, downy; flesh rich yellow tinged with red, red at stone, fibrous, meaty, juicy; stone free; large, obovate, thick, with considerable point; flavor pleasant subacid, nearly sweet; quality good; apparently an extra good market sort, productive, season latter half of August in 1910.

Davidson.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, wide, serrated, glands reniform; fruit uniform, roundish, somewhat compressed, projection on suture side, flattened at ends, sides sometimes unequal, small to medium; suture to apex, very shallow; apex rounded; color pale yellow, somewhat washed with bright red and a dark purple blush; skin thin, tender, downy; flesh creamy yellow, juicy, fibrous, meaty, tender; stone free, small, broadly obovate with slight point, thick, finely pitted; flavor nearly sweet; quality fair; season July 12 to 28 in 1910.

Delaware,—Tree erect spreading, vigorous, stocky; bark nearly smooth, dark, twigs bright; foliage abundant, healthy, dark green, crinkly; leaf large, long, narrow to broad, finely serrated, smooth, glands orbicular; fruit uniform, round, lopsided, size medium; suture to apex, shallow; apex rounded; color light yellow with rich mottling, blushed, very attractive; skin thin, tough downy; flesh white, tinged red, red at stone; melting, juicy, fibrous; stone free, large, obovate, lopsided, pitted; flavor subacid, spicy, quality excellent; very productive, extra good early white variety to follow Mountain rose; season August 3 to 18 in 1910.

Deming.—Tree erect, vigorous, stocky; bark somewhat rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow, serrated, glands orbicular; fruit uniform, medium size, round, sides unequal tapering somewhat at base; suture beyond apex, very shallow; apex rounded with small point; color yellow with heavy red and scarlet blush; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, meaty; stone free, large, obovate with small point, thick, coarsely pitted; flavor pleasant mild subacid, vinous; quality good; season September 3 to 13 in 1910.

Denton,—Tree erect, vigorous, stocky; bark rough, dark, twigs bright; foliage abundant, healthy, light green; leaf large, long, rather broad, serrated, glands orbicular; fruit uniform, Elberta-shape, slightly oblong, sides flattened and a little unequal, medium size; suture to apex, shallow; apex rounded; color pale yellow with small dark blush and a little mottling; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, meaty; stone free, large, outline oblong with projection at base on one side, blunt point, thick, coarsely pitted; flavor mild sabacid, very bitterish, quality fair; season August 16 to 24 in 1910.

Denry (*Cling*),—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands orbicular; fruit uniform, roundish, sides unequal, medium to above; suture beyond apex, moderately deep; apex rounded; color creamy with faint blush; skin thick, tough, downy; flesh white, moderately juicy, meaty; stone cling, large, oblong, thick, coarsely pitted; flavor pleasant, nearly sweet; quality fair; ripened September 3, in 1910.

Dewey (*Admiral*),—Tree spreading, vigorous, stocky; bark rough, dark, twigs green; foliage abundant, healthy, dark green; leaf large, long finely serrated, glands reniform; fruit uniform, roundish, sometimes flattened at ends, sides often unequal, medium size; suture beyond apex, shallow; apex a slight point; color rich yellow mottled and blushed with bright dark red and purple markings; skin thick, tough, downy; flesh rich yellow, green at stone, moderately juicy, meaty; flavor mild pleasant subacid, nearly sweet; quality good; stone semi-cling, large obovate with small tip, thick, coarsely pitted; season July 10 to 29 in 1910.

Double Crop,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to rather wide, serrated, glands orbicular; fruit uniform, roundish, sides unequal, medium size; suture beyond apex, a line; apex rounded; color pale yellow mottled with heavy red, some of it almost black, very attractive; skin thick, tough, downy; flesh cream colored, much stained with red on side of deep color, red at stone, juicy, fibrous, meaty; stone cling, large, obovate with small point, thick; flavor pleasant, sweet, spicy; quality good; ripened August 19 in 1910.

Dover,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf large, long, broad, serrated, glands reniform; fruit roundish, a little long in outline, both ends of suture side undeveloped, somewhat flattened at sides toward apex; size medium; suture to apex, a line; apex a minute point, rounded; color rich yellow with bright and dull red, very attractive; skin thick, tough, somewhat downy; flesh rich yellow, tinged with red, red at stone; juicy, fibrous, meaty; stone free, large, obovate, considerably lopsided, rather flat, with considerable point, finely pitted; flavor pleasant mild subacid, spicy; quality good; probably especially good for market; season August 15 to 25 in 1910.

Downer,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf medium to large, long, medium width, crinkled, finely serrated, glands reniform; fruit uniform, roundish, tapering to apex, sides often unequal, medium size; suture to apex, moderately deep; apex pointed; color yellow, nearly covered with bright blush, mottled, very attractive; skin thick, tough, downy; flesh pale yellow, red at stone, juicy, meaty; stone cling; flavor pleasant, nearly sweet; quality fair; productive; season September 3 to 13 in 1910.

Early Crawford.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark geen; leaf crinkled, large, long, narrow to moderately wide, finely serrated, glands orbicular; fruit uniform, roundish, irregular, sides unequal, suture side much bulged, size medium; suture beyond apex, rather deep; apex rounded; color rich yellow blushed and mottled with bright light and dark red; skin thick, moderately tough, downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, moderately large, roundish oval or obovate with point, thick, coarsely pitted; flavor rich mild pleasant subacid, somewhat spicy, quality good to very good; season August 6 to 24 in 1911.

Early Mamie Ross.—Tree erect, spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium, long, narrow to wide, somewhat crinkled, glands reniform; fruit uniform, roundish, sides often unequal, flattened a little at ends, large; suture to apex, deep; apex rounded; color pale yellow with dull red blush; skin thin, tough, downy; flesh creamy yellow faintly tinted with red, juicy, fibrous; stone free, large, obovate, thick, coarsely pitted; flavor very mild subacid, rather flat; quality fair; season July 25 to August 4 in 1910.

Early Michigan,—Tree rather spreading, moderately vigorous, stocky; bark moderately smooth, bright, twigs bright; foliage abundant, diseased, light green; leaf medium size, long, narrow to broad, finely serrated, glands both orbicular and reniform; fruit uniform, rots considerably, roundish, above medium to large; suture to apex; apex very small point or depressed; color white with bright red or dull heavy blush, somewhat mottled, very attractive; skin thick, tough, considerably downy; flesh greenish white, slightly red at stone, juicy, fibrous, meaty, very rich; stone large, obovate with point; flavor nearly sweet, spicy; quality excellent; season July 17 to 25 in 1910.

Early Silver,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright, foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands reniform; fruit uniform, round, medium size; suture to apex, a line; apex rounded; color creamy with thin light pink blush, attractive, light colored fruit; skin somewhat downy; flesh white, red at stone, rather dry, very fibrous; stone free, medium, obovate with sharp point, thick; flavor rich, spicy; quality good; ripened August 9 in 1910.

Early Smock,—Tree erect, vigorous, stocky; bark nearly smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf medium to large, long, medium to broad, finely serrated, glands reniform; fruit uniform, roundish, sides often unequal, medium size; suture to apex, shallow; apex rounded; color rich yellow with bright and dark red mottling, attractive; skin thick, tough, downy; flesh yellow, red at stone, melting, moderately juicy, fibrous; stone free, large, obovate with point, thick, finely pitted; flavor mild subacid, not much character; quality fair; very productive; season September 4 to 21 in 1910.

Early Toledo,—Tree spreading, vigorous, stocky; bark somewhat rough, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, rather broad, serrated, glands orbicular; fruit uniform, roundish, flattened at ends, sides often unequal, extended on suture side, small to medium; suture to apex or beyond, moderately deep; apex rounded; color rich yellow, almost entirely overspread with rich light and purplish red mottling; skin thin, tough, somewhat downy, smooth in appearance; flesh pale yellow, slightly tinged with red, juicy, fibrous; stone free, small to medium, ovate with considerable point, thick, coarsely pitted; flavor nearly sweet, sometimes bitterish; quality fair; season July 18 to August 2 in 1910.

Early York,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow, serrated, glands orbicular; fruit uniform, roundish, sides unequal, flattened at base, small to medium size; suture to apex, a line; apex rounded; color pale yellow with blush over most of fruit; skin downy; flesh creamy white, red at stone, juicy, fibrous, meaty; stone free, medium, roundish with small point, thick; flavor mild subacid, rich; quality good; season August 7 to 10 in 1910.

Eaton,—Tree erect, vigorous, not stocky; bark rough, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, glands reniform; fruit uniform, badly diseased, roundish, flattened at ends, small; suture to apex, a line; apex rounded with minute point; color white, small pink blush; skin thin, tough, somewhat downy; flesh creamy white, tinted red, red at stone, moderately juicy, fibrous; stone free, small, obovate with small point, thick, smoothly pitted; flavor pleasant subacid, nearly sweet; quality fair; ripened August 30 in 1910.

Ede (Captain),—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, light green; leaf large, long, narrow, glands orbicular or reniform; fruit uniform, roundish pointed, flattened slightly toward apex, medium size; suture three-fourths around fruit, a line; apex rounded; color rich yellow with rich blush and mottling; very attractive; skin thin, tough, downy, flesh rich yellow, red at stone, melting, juicy, fibrous; stone free, large, oblong, pointed; flavor sweet; quality good; season August 6 to 12 in 1910.

Edgemont Beauty,—Tree erect, vigorous; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf moderately large, long narrow, to moderately wide, serrated, glands reniform, fruit round, lopsided, flattened at base, medium size; suture beyond apex, shallow; apex rounded; color rich yellow washed and mottled with bright red and dark scarlet; skin thin, tough, downy; flesh rich yellow, red at stone, melting, juicy; stone free, large, nearly elliptical, long point, very thick, finely pitted; flavor rich, mild, pleasant subacid, spicy; quality excellent; a very attractive sort; season September 2 to 10 in 1910.

Elberta.—Tree upright-spreading, vigorous, stocky; bark rather rough, dull, twigs bright; foliage abundant, healthy, light green; leaf large, long, rather wide, serrated, glands reniform; fruit uniform, oval, slightly flattened, medium to large; suture beyond apex, deep at apex only; apex rounded; color greenish yellow with red blush, rather dull; skin moderately thick, tough, downy; stone free, rather large, roundish oval, only moderately thick, coarsely pitted; flesh rich yellow, juicy, fibrous, meaty; flavor mild subacid; quality fair; ripened August 18 in 1910.

Elberta Cling.—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, light green; leaf medium size, long, narrow to moderately wide, serrated, glands reniform; fruit uniform, roundish, slightly unequal, often lopsided, flattened at ends, medium size; suture beyond apex, moderately deep; apex rounded with small depressed point; color yellow, blushed and mottled with bright light and dull purplish red; skin thick, tough, downy; flesh rich yellow, tinged with red, red at stone, juicy, meaty; stone cling, large, oval, thick; flavor mild pleasant subacid, somewhat spicy; quality good; ripened August 15 in 1911.

Elvir,—Tree erect, spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, light green; leaf medium size, long, narrow, serrated, glands reniform; fruit uniform, roundish, sides unequal, cavity moderate to rather deep, large to very large; suture beyond apex, shallow; apex flattened with a minute tip; color pale yellow with a little thin red blush, not attractive; skin thick, tough, slightly downy; flesh creamy yellow, very slightly red at stone, very juicy, melting, fibrous, meaty; stone nearly free, very large, roundish oval, thick; flavor mild subacid, spicy; quality good; ripened July 30 in 1910.

Elrose,—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow, serrated, glands reniform; fruit uniform, roundish, lopsided, medium to large; suture to apex, a line; apex rounded; color pale greenish yellow with rich blush; skin nearly smooth, thin, tough; stone free, large, obovate with point; flesh yellowish white, tinged with red, juicy, meaty; flavor mild subacid, spicy, sprightly; quality good; season August 2 to 11 in 1910.

Emma,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium, moderately long, wide, crinkled, coarsely serrated, glands reniform; fruit fairly uniform, roundish, compressed, halves unequal, small to medium; suture to apex, shallow; apex pointed; color rich yellow, heavy rich red, attractive; skin thin, downy; flesh yellow, red at stone, juicy, fine, slightly fibrous, meaty; stone free, medium, obovate-pointed, thick; flavor mild pleasant subacid, spicy; quality good; ripened August 19 in 1907.

Emperor,—Tree somewhat spreading, very vigorous, stocky; foliage abundant; healthy, light green; leaf medium to large, long, medium to wide, finely serrated, glands reniform; fruit uniform, round, sides often unequal, medium to large; suture beyond apex, shallow; apex rounded; color rich yellow, with rich red marked with scarlet splashes, very attractive; skin thick, tough, downy; flesh rich yellow, red at stone, moderately juicy, fine grained; stone free, obovate, considerable tip, thick, coarsely pitted; flavor mild subacid; quality good; heavy bearer, apparently good late market sort; season September 8 to 15 in 1910.

Engle (Mammoth).—Tree spreading, vigorous, stocky; bark rough, twigs bright; foliage abundant, healthy, light green; leaf medium, rather narrow, serrated, smooth; glands very small, orbicular; fruit uniform, considerable rot, roundish, sides often unequal, flattened at base, small; suture to apex, a line; apex rounded; color rich yellow with heavy blush over three-fourths of fruit, mottled, very attractive; skin thin, tough, somewhat downy; flesh rich yellow, melting, juicy, a little fibrous; stone free, medium size, nearly round, pointed, thick; flavor pleasant mild subacid; quality good; season August 9 to 11 in 1910.

Eureka.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, moderately long, medium to wide, serrated, glands reniform; fruit somewhat diseased with fruit spot, uniform, roundish, often lopsided, slightly flattened, somewhat oblong, medium size; suture to apex, shallow; apex rounded; color creamy white, blotched and mottled with rich red, almost solid blush on one side; skin thin, moderately tender, somewhat downy; flesh white, a little red at stone, melting, juicy, meaty; stone free, moderately large, roundish oval, thick, flavor pleasant subacid, nearly sweet; quality fair; season July 23 to August 2 in 1910.

Everbearing.—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf medium size, long, mostly narrow, serrated, glands reniform; fruit roundish tapering to apex, above medium size; suture to apex, a line; apex pointed; color dull green washed and broken striped with dull carmine, clouded frosty white; skin thin, tough and bitter, downy; flesh white, red beneath skin, white at stone, juicy, fibrous; stone free, large, roundish with considerable point, thick, finely pitted; flavor nearly sweet; quality fair; ripened August 22 in 1910.

Family Favorite,—Tree ercet, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, roundish-oblong, sides unequal, medium to above in size; suture to apex, a line; apex rounded; color pale yellow with thin blush, attractive light color; skin thin, tough, downy; flesh white, tinged with red, melting, very juicy, fibrous; stone free, very large, elliptical flowing outline, flat; flavor nearly sweet, watery; quality fair; season August 5 to 16 in 1910.

Fitzgerald,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow, serrated, glands orbicular; fruit uniform, roundish, lopsided, flattened at ends, medium to large; suture to apex, a line; apex rounded; color rich yellow, rich blush, mottled, fairly attractive; skin thick, tough, somewhat downy; flesh rich yellow, red at stone, melting, juicy, slightly fibrous, meaty; stone free, large, obovate, lopsided, pointed, thick; flavor pleasant; rich subacid; quality good; season August 10 to 15 in 1910.

Ford.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, glands reniform; fruit uniform, roundish, sides sometimes unequal, slightly flattened at ends, medium size; suture to apex or beyond, deep; apex rounded; color pale yellow, mottled bright and dark red; skin thick, tough, slightly downy; flesh white, tinged with red, slightly red at stone, juicy, tender, fibrous; stone free, large, obovate-pointed, thick, coarsely pitted; flavor mild subacid, rather flat; quality fair; season July 26 to August 4 in 1910.

Ford Late,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, medium to broad, finely serated, crinkled, glands orbicular; fruit uniform, roundish, often flattened on suture and opposite sides, sides often unequal, medium or above in size; suture to apex, shallow; apex rounded with small point; color creamy with small bright blush; skin nearly smooth, thin, tough; flesh white, moderately juicy, fibrous; stone free, small, long obovate with small point, thick, coarsely pitted; flavor mild subacid, a little vinous; quality fair; season September 14 to 23 in 1910.

Foster.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately broad, serrated, glands orbicular; fruit uniform, roundish, a little lopsided, flattened at base, medium to large; suture to apex, a line; apex slightly pointed; color rich yellow with bright blush and dark red mottling; skin smooth, thick, tough; flesh yellow, red at stone, moderately juicy, meaty; stone free, large, round, with point, deeply pitted; flavor nearly sweet, spicy; quality good; season August 2 to 22 in 1910.

Fox Seedling,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands orbicular; fruit uniform, roundish tapering sometimes on sides toward apex, large; suture to apex, shallow; apex pointed; color creamy with small blush; skin thick, tough, very downy; flesh creamy, red at stone, very juicy, fibrous; stone free, large, obovate with small point, flat or thick, finely pitted; flavor mild pleasant subacid; quality good; ripened September 13 in 1911.

Frances,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium, moderately long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, medium to large, roundish somewhat oblong, sides unequal, flattened on suture side, lopsided often almost oblique; suture to apex, a line; color rich yellow with bright red blush and mottling of rich red and carmine, very attractive, skin thin, tough with short down; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, obovate with point, thick, pitted moderately coarse and rough; flavor rich, vinous, pleasant mild subacid, nearly sweet; quality excellent; resembles Crawford Late; ripened September 5 in 1911.

Frederica,—Tree somewhat spreading, vigorous, stocky; bark nearly smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, wide, finely serrated, glands orbicular, crinkled; fruit uniform, large, roundish, one sided development, sides often unequal, small tip; suture to apex, shallow; apex pointed; color light yellow, washed with heavy dark red and mottled with light red; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, fibrous, melting; stone free, very large, obovate with point, thick, coarsely pitted; flavor rich, spicy; quality good; season August 29 to September 10 in 1910.

Garfield,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf moderately large, long, narrow to rather wide, serrated, glands orbicular; fruit roundish, lopsided, medium size, suture to apex, shallow, apex a small point; color rich yellow, blushed and mottled with rich deep red, very attractive; skin nearly smooth, thick, tough, bitter; flesh yellow, red at stone, moderately juicy, meaty; stone free, large; flavor rich, spicy, sprightly, quality excellent, season August 5 to 22 in 1910.

Genii,—Tree slightly spreading, vigorous, stocky; bark rough, dark, twigs green; foliage abundant, healthy, light green; leaf medium, long, narrow, serrated, crinkled, glands orbicular or reniform; fruit uniform, roundish with small tip, small; suture to apex, shallow; apex pointed; color lemon yellow; skin thick, tough, downy; flesh creamy, juicy, fibrous, meaty; stone cling, medium size, obovate with distinct point, very thick; flavor nearly sweet; quality fair; season August 14 to 22 in 1910.

Georgia Cling,—Tree spreading, vigorous, stocky; bark rather smooth, dark, twigs rather green; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands orbicular or wanting; fruit uniform, roundish, somewhat elongated, sides unequal, somewhat lopsided, medium to large; suture to apex, shallow; apex a small point, rounded; color white with bright mottlings over most of surface, dark blush; skin thick, tough, downy; flesh white, juicy, spicy, fibrous, meaty; flavor pleasant mild subacid; quality good; stone cling, large, elliptical with point, thick; season August 26 to 30 in 1910.

Gibson,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands orbicular; fruit uniform, globose, flattened at ends, medium size; suture to apex, a line; apex rounded; color pale yellow partly blushed with dull and heavy red or bright red or both; skin thin, tender, somewhat downy; flesh white, red at stone, melting, juicy, fibrous; stone free, large, roundish with short point; flavor pleasant; quality good; ripened August 5 in 1910.

Globe,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf, large, long, wide, crinkled, serrated, glands orbicular; fruit uniform, roundish, halves unequal, often lopsided, large to very large; suture beyond apex, shallow; apex slightly pointed; color yellow, mottled with bright attractive red, heavy dark blush; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, medium size, obovate with point, thick, flavor mild subacid, spicy; quality excellent; season August 19 to 30 in 1907.

Gold Drop,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf large, long, broad, finely serrated, glands reniform; fruit uniform, a little diseased; roundish, often tapering to apex, sides often unequal, sometimes lopsided, sometimes flattened at ends, medium large; suture to apex, shallow; apex pointed; color pale greenish yellow with small thin blush; skin nearly smooth, thick, tough; flesh white, moderately juicy, tinged red slightly at stone; stone free, small, obovate with considerable tip, thick, coarsely pitted; flavor pleasant, rich, nearly sweet; quality good; very productive; season September 15 to 23 in 1910.

Gold Miller,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, roundish, lopsided, flattened at ends, medium size; suture to apex, a line; apex rounded, color rich yellow with rich dull blush, very attractive; skin thin, tough, downy; flesh yellow, tinged with green, red at stone, juicy, fibrous, meaty; stone free, large, roundish with point, thick; flavor pleasant; quality good; season August 6 to 10 in 1910.

Grady,—Tree erect spreading, vigorous, stocky; bark somewhat rough, dark, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to wide, serrated, glands reniform; fruit uniform, large, free from disease, Elberta shape, sides slightly unequal; suture to apex, a line; apex rounded; color rich yellow, rich heavy blush and bright mottling, very attractive; skin thick, tough, somewhat downy; flesh rich, yellow, tinged with red, red at stone, juicy, fibrous, meaty; flavor nearly sweet, spicy; quality excellent; stone free, large, oblong, rather flat; apparently an extra good market sort; season August 19 to 30 in 1910.

Greensboro,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, broad, coarsely serrated, glands reniform; fruit uniform, oblong flattened at sides, large; suture to apex, shallow; apex rounded with small point; color creamy white, blushed rich bright red, very attractive; skin thin, tender with considerable down; flesh white stained with red, tender, juicy; stone semi-cling or cling, medium size, roundish, thick; flavor mild pleasant subacid; quality fair to good; season July 3 to 9 in 1910.

Grosse Mignonne,—Tree ercet spreading, very vigorous; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green, glossy; leaf large, long, broad; serrated, glands orbicular; fruit uniform, nearly round, large; suture to apex, a line; apex a small point; color pale yellow, bright and very dark red, mottling in patches following suture side and often entirely around the fruit; skin rather thick, tough, somewhat downy; flesh white, tinged with red, red at stone, juicy, fibrous; stone free, very large, obovate, considerable point, thick, coarsely pitted; flavor pleasant mild subacid; quality good; productive, a promising white peach; season August 15 to 25 in 1910.

Haas (John).—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to wide, serrated, glands reniform; fruit uniform, roundish, flattened at ends, small; suture to apex; apex rounded; color creamy with bright blush; skin thin, tender, slightly downy; flesh white, melting, juicy, meaty; stone free, medium size, roundish, pointed, much pitted; flavor nearly sweet; quality fair; season July 23 to 29 in 1910.

Hale Early.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately broad, serrated, glands orbicular or reniform; fruit uniform, free from disease, roundish, sides often unequal, often extended on suture side, medium size; suture to apex, deep; apex rounded; color pale yellow, mottled striped and blushed with rich light and varied dark red; skin thin, tough, downy, appearance rough; flesh pale yellow, sometimes tinged red, tinged red at stone, juicy, fibrous; stone free, small, elliptic outline with small point, thick, coarsely pitted; flavor mild lively subacid, nearly sweet; quality fair; season July 23 to 28 in 1910.

Hance (Golden).—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands orbicular; fruit uniform, round, sides unequal and somewhat lopsided, flattened at ends, medium size; suture to apex, a line; apex slightly pointed; color yellow with dull red over most of surface; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, slightly fibrous, meaty; stone free, medium size, roundish-obovate with considerable point, thick; flavor rich, spicy; quality good; season August 11 to 22 in 1910.

Heath Free.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, wide, smoothly serrated, crinkled, glands reniform; fruit uniform, round, sides often unequal, large; suture to apex, very shallow; apex a minute point, rounded; color very pale yellow, very slightly blushed; skin thick, tough, downy; stone free, large, obovate, thick, coarsely pitted; flesh white, melting, juicy, fibrous, meaty; flavor rich, spicy, nearly sweet; quality excellent; ripened August 30 in 1910.

Heath (White).—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green, leaf small, short, narrow, finely serrated, glands orbicular; fruit uniform, roundish to short oblong, usually flattened at ends, small; suture to apex, shallow; apex rounded; color very pale yellow with rich blush and mottling; skin nearly smooth, thick, tough; flesh white, tinted red at stone, juicy, fibrous; stone free, medium, elliptical with small point, thick, finely pitted; flavor nearly sweet; quality fair; ripened September 8 in 1910.

Heidleberg.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, glands orbicular, somewhat crinkled; fruit medium large, uniform, round, sometimes flattened towards apex at side; lopsided, sides unequal; suture to apex, a line; apex a small point, rounded; color rich yellow, almost entirely blushed, attractive; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, large, thick, with considerable point; flavor pleasant, spicy, nearly sweet; quality excellent; season August 15 to 25 in 1910.

Henderson.—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, crinkled, finely serrated, glands orbicular; fruit uniform, roundish, sides unequal, often lopsided, flattened toward apex, medium to above; suture beyond apex, shallow; apex rounded; color yellow, mottled bright and dark red with dull purplish stripes and patches; skin thick, rather tender, downy; flesh yellow, red at stone, juicy, fibrous, meaty; stone free, large, long obovate with point, thick; flavor mild pleasant subacid, somewhat spicy; quality fair to good; ripened August 8 in 1911.

Heard ('s Beauty),—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, somewhat diseased, dark green; leaf medium size, moderately long, narrow to moderately wide, finely serrated, glands reniform; fruit uniform, roundish, sides compressed, medium size; suture three-fourths around fruit, shallow; apex rounded with small point; color pale yellow with small blush or mottling of bright red; skin thin, tough, with considerable down; flesh white tinged with yellow, moderately juicy, very firm, meaty; stone cling, large, obovate with small point, thick, finely pitted; flavor nearly sweet; quality fair; ripened September 19 in 1911.

Hiley,—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark, green; leaf large, long, narrow, serrated, glands reniform; fruit uniform, roundish, oblong, sides unequal, flattened slightly toward apex, medium size; suture to apex, a line; apex slightly pointed; color pale yellow with bright blush and dark mottling, attractive light colored fruit; skin moderately thick, moderately tough, slightly downy; flesh creamy white, tinged with red, red at stone, moderately juicy, fine, meaty; stone free, large, elliptical with flowing outline and long point; flavor rich, pleasant, nearly sweet; quality good; ripened August 4 in 1910.

Hobson,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, sharply serrated, glands orbicular; fruit uniform, oval, slightly flattened, sides unequal, medium size; suture beyond apex, shallow; apex slightly pointed; color white with thin red blush; skin smooth, thin, tender, slightly downy; flesh white, red at stone, juicy, fine, meaty; stone nearly free, large, roundish-oblong, moderately thick with long point; flavor rich subacid, slightly bitterish; quality good; ripened August 19 in 1907.

Holderbaum,—Tree spreading, vigorous, stocky; bark rough, dark, twigs bright; foliage abundant, healthy, light green; leaf large, long, broad, serrated, smooth, glands reniform; fruit uniform, free from disease, roundish-oval, restricted at apex on suture side, medium to above in size; suture to apex, shallow; apex rounded; cream colored with heavy blush; skin thick; tough, considerably downy; flesh white, slightly red at stone, juicy, meaty; stone free, large, elliptical with small point, thick, smoothly pitted; flavor nearly sweet, spicy; quality good; season July 23 to August 3 in 1910.

Honest John,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long broad, finely serrated, glands reniform; fruit uniform, free from disease, roundish with small tip, medium or above in size; suture beyond apex, shallow; apex pointed; cream colored, mottled and blushed with heavy bright red; skin thin, tough, downy; flesh white, juicy, meaty; stone cling, large, obovate with considerable point, very thick, finely pitted; flavor pleasant subacid; nearly sweet; quality fair; season September 8 to 16 in 1910.

Horton (Philip).—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, medium to broad, crinkled, finely serrated, glands orbicular; fruit uniform, some disease, roundish, sides unequal, lopsided, large; suture to apex, deep or shallow; apex rounded; color pale yellow with rich deep blush, rather attractive; skin thin, tough, downy; flesh rich yellow, juicy, meaty; stone semi-cling, large, elliptical with sharp point, very thick, coarsely pitted; flavor nearly sweet, not much character; quality fair; season September 17 to October 1 in 1910.

Husted,—Tree spreading, vigorous, stocky; bark somewhat rough, dull, twigs bright; foliage abundant, healthy, light green; leaf large, long, narrow to broad, serrated, glands orbicular; fruit uniform, roundish, a little lopsided, medium size; suture beyond apex, shallow; apex a slight point; color yellow, thin dull red blush; skin thin, tough, downy; flesh greenish white, juicy, meaty; stone free, small, oval, thick; flavor mild pleasant subacid; quality fair; season August 2 to 10 in 1910.

Hynes (Surprise).—Tree erect, vigorous, stocky; bark smooth, bright, bright: foliage abundant, healthy, dark green; leaf large, long, narrow to wide, finely serrated, glands orbicular; fruit uniform, free from disease, roundish or roundish oblong, sides unequal, medium to above; suture to apex, moderately deep; apex rounded or with a very slight tip; color pale yellow overspread with rich light and dark red; skin thick, tender, downy; flesh very pale yellow, moderately juicy, tender, fibrous; stone free, medium, oblong with long point, flat, coarsely pitted; flavor nearly sweet; quality good; season July 31 to August 6 in 1910. ,

Ingold (Lady),—Tree erect, vigorous, stocky; bark rough, dull, twigs rather green; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands orbicular; fruit uniform, roundish, lopsided, large; suture to apex, shallow; apex rounded; color yellow, heavy red blush and mottling; skin thick, tough, downy; flesh yellow, red at stone, meaty; stone free, large, oval, lopsided with considerable point, coarsely pitted; flavor subacid; quality fair; season August 1 to 3 in 1910.

Iron Mountain.—Tree spreading, vigorous, stocky; bark rough, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to wide, finely serrated, glands orbicular; fruit uniform, free from disease, pointed at apex, large; apex pointed; color very pale yellow sometimes with a small blush; skin thick, tough, somewhat downy; flesh creamy, juicy, fibrous, tender; stone free, medium, long obovate to long elliptical with long point, thick, markings in folds; flavor nearly sweet; quality fair; season September 8 to 21 in 1910.

Jacques (Rareripe),—Tree spreading, vigorous, stocky; bark nearly smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium size, long, broad, finely serrated, glands reniform; fruit uniform, roundish, flattened at ends, sides often unequal, medium size; suture beyond apex, shallow; apex rounded; color rich yellow, almost entirely mottled with rich dark red and purple; skin thick, tough with heavy down; flesh yellow, tinged red, red at stone, rather dry, fine, a little fibrous; stone free, very small, elliptical, thick, very finely pitted; flavor mild subacid, nearly sweet, spicy; quality good; ripened August 31 in 1910.

Japan Blood.—Tree spreading, moderately vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, a little diseased, dark green, leaf moderately large, moderately long, narow to broad, coarsely serrated, glands reniform; fruit uniform, roundish with slight point, sides flattened and unequal, medium size; suture to apex, moderately deep; apex rounded; color yellow mottled with bright red; skin thick, tough, somewhat downy; flesh white, stained red throughout, moderately juicy, fibrous, meaty; stone free, small, obovate, pointed, sometimes lopsided, thick, coarsely pitted; flavor mild subacid, usually bitter; quality poor; season July 2 to 11 in 1910.

Jarrell (*Late White*),—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium size, long, broad, finely serrated, glands orbicular; fruit uniform, large, roundish, sometimes oblong, sides unequal; suture sometimes entirely around fruit, often deep; apex rounded; color creamy with small dull blush; skin thick, tough with considerable down; flesh creamy, red at stone, juicy, fibrous; stone free, large, obovate with short tip, thick, rather coarsely pitted; flavor a little bitterish; quality poor; ripened September 13 in 1911.

Juno,—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands mostly reniform, a few orbicular; fruit uniform, roundish, lopsided, sides unequal, moderately large; suture to apex or beyond, shallow; apex pointed; color light yellow with bright blush and mottling, attractive; skin thick, tough, downy; flesh rich yellow, red at stone; stone cling, large, roundish elliptical with considerable tip, very thick, coarsely pitted; texture moderately juicy, meaty; flavor nearly sweet, spicy; quality good; season September 3 to 23 in 1910.

Kalamazoo,—Tree spreading, vigorous, stocky; bark smooth, dull, twigs rather green; foliage abundant, healthy, light green; leaf large, long, rather narrow, serrated, glands reniform; fruit nearly uniform, some rot, roundish with point, sometimes flattened on suture side, medium size; suture to apex, shallow; apex pointed or sometimes rounded; color yellow with heavy blush, moderately attractive; skin thick, rather tender, downy; flesh yellow, red at stone, moderately juicy, fibrous; stone free, large, roundish with point, thick; flavor mild subacid, nearly sweet; quality fair; season August 21 to 26 in 1910. ,

Klondyke,—Tree erect, vigorous, stocky; bark rough, dark, twigs very bright; foliage abundant, healthy, dark green; leaf medium to large, long, medium to broad, finely serrated, crinkled, glands orbicular; fruit uniform, roundish oblong, ribbed, sides unequal and compressed toward apex, large, suture to apex, shallow; apex pointed; color pale yellow, mottled bright and dark red giving a spotted appearance; skin thick, tough, downy; flesh creamy, tinged red on sunny side, red at stone, moderately juicy, rather fine grained, very meaty; stone free, large, long oblong with small point, flat, coarsely pitted; flavor very mild subacid, slightly vinous; quality fair to good; season September 4 to 13 in 1910.

Krummel (*October*),—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, medium to broad, finely serrated, glands orbicular; fruit uniform, roundish, flattened at ends, sides often unequal, medium size; suture to apex, shallow; apex rounded with a small point; color light yellow with small red blush; skin thick, tough, a little downy; flesh rich yellow, red at stone, moderately juicy, meaty; stone free, large, broad spindle shape, thick, slight point, coarsely pitted; flavor mild subacid, vinous; quality fair; season September 8 to 23 in 1910.

Late Admirable (*Teton de Venus*),—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, roundish, slight tip, sides unequal, a little lopsided, medium size; suture short, an indistinct line; apex pointed; color light yellow with a little heavy red and bright mottling, dull colored; skin thick, tough, downy; flesh greenish yellow, red at stone, juicy, fibrous, meaty; stone free; very large, elliptical, strongly keeled, considerable point, very thick, coarsely pitted; flavor mild subacid, slightly bitterish; quality fair to good; season August 16 to 29 in 1910.

Late Admiral.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf large, long, broad, finely serrated, glands orbicular; fruit uniform, free from disease, round, sometimes lopsided, sides often unequal, considerable tip, medium size; suture to apex, shallow; apex pointed; color creamy with bright blush over three-fourths of surface, very attractive; skin thick, tough, downy; flesh white, red at stone, melting, juicy, fibrous, meaty; stone free, moderately large, obovate with considerable tip, thick, finely pitted; flavor mild pleasant subacid, somewhat vinous; quality good; productive, apparently a good late sort; season September 2 to 15 in 1910.

Late Crawford.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, roundish pointed, lopsided, sides unequal, large; suture to apex, shallow; apex pointed; color rich yellow, marbled with rich bright and dark red; skin thin, tough, short down; flesh rich yellow, red at stone, melting, juicy, slightly fibrous, meaty; stone free, very large, obovate with short point, thick, coarsely pitted; flavor mild rich subacid, nearly sweet, spicy; quality superb; season August 28 to September 2 in 1910.

Late Elberta.—Tree erect, vigorous, stocky; bark almost smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkly; leaf large, long, broad, serrated, glands reniform; fruit uniform, roundish, slightly oblong, sometimes a little flattened, large; suture to apex, a line; apex rounded; color rich yellow, mottled and blushed with rich red, very attractive; skin nearly smooth, thick, tough, flesh rich yellow, tinged with red, red at stone, melting juicy, meaty; stone free, large, obovate, one edge defective, thick, coarsely pitted; flavor rich, nearly sweet, spicy; quality excellent; very productive, apparently extra good market sort; ripened about one week later than Elberta, season August 20 to 30 in 1910.

Late Rose.—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, crinkled, glands reniform; fruit uniform, roundish with small point, above medium; suture to apex, a line; apex pointed; color dull green with bright red blush, not very attractive; skin thick, tough, bitter, somewhat downy; flesh greenish white, red at stone, juicy, meaty; stone free, very large, obovate with small point, thick, coarsely pitted; flavor mild subacid, nearly sweet; quality fair; season September 2 to 10 in 1910.

Late Stump.—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long narrow to moderately wide, serrated, glands orbicular; fruit uniform, obovate, pointed, bulged slightly on suture side, small; suture to apex, shallow; apex pointed; color pale greenish yellow mottled and blushed with light and dark red; skin thick, tough, downy, flesh white, red at stone; moderately juicy, fibrous, meaty; stone free, large, obovate, pointed, thick; flavor pleasant subacid, nearly sweet; quality fair; ripened August 28 in 1910.

Lee (General).—Tree erect, vigorous, stocky; bark a little rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands reniform; fruit uniform, roundish oblong, sides sometimes unequal and lopsided, medium size; suture beyond apex, a line, apex rounded; color pale yellow with dull blush; skin nearly smooth, thick, tough, bitter; flesh white, red at stone, melting, juicy, a little fibrous; stone semi-cling, large, oblong with small point, thick, pitted; flavor mild subacid, bitterish; quality fair; season August 12 to 16 in 1910.

Lemon Cling.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide serrated, glands reniform; fruit uniform, roundish, tapering to apex, sides somewhat unequal, pronounced bulge on suture side, flattened on side opposite suture, medium size; suture to apex, shallow; apex pointed; color rich yellow with thin mottling and blush of red, attractive; skin thick, tough, downy; flesh rich yellow, juicy, fibrous, meaty; stone cling, large, elliptical with short point, thick, pitted; flavor subacid, somewhat spicy; quality fair; season August 20 to 29 in 1910.

Levy (*Late*),—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium, long, narrow, serrated, glands orbicular; fruit uniform, roundish, sides sometimes unequal, size above medium; suture beyond apex, deep; apex rounded with small point; color rich yellow mottled and blushed with bright and dull dark red, fairly attractive; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, meaty; stone cling, large, broadly elliptical with blunt tip, thick; flavor mild subacid; quality fair; ripened September 16 in 1910.

Lewis,—Tree spreading, vigorous, stocky; bark rough, bright, twigs bright; foliage abundant, healthy, light green; leaf large, long, narrow, serrated, glands orbicular; fruit uniform, roundish, medium size; suture to apex, deep; apex pointed; color rich yellow with heavy rich blush, attractive; skin thick, tough, somewhat downy; flesh rich yellow tinged red, red at stone; stone free, obovate, pointed, thick; texture melting, juicy, fibrous; flavor nearly sweet, rich, pleasant; quality good; season August 6 to 19 in 1910.

Lewis Late.—Tree spreading, vigorous, stocky; bark a little rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, narrow to broad, crinkled, finely serrated; glands orbicular; fruit uniform, roundish, sides unequal, medium size; suture to apex, deep; apex rounded with a small point; color yellow mottled bright red, attractive; skin thick, tough, downy; flesh yellow, red at stone, moderately juicy; stone cling, large, elliptical with small tip, thick, finely pitted; flavor nearly sweet; quality fair; ripened September 12 in 1910.

Linthicum (*White Late*),—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, crinkled, serrated, glands orbicular; fruit uniform, roundish with point, sides unequal, medium or smaller; suture to apex, a line; apex pointed; color pale yellow with heavy blush; skin thick, tough, somewhat downy; flesh light yellow, red at stone, moderately juicy, fibrous; stone free, large, obovate with long sharp point, thick, coarsely pitted; flavor pleasant mild subacid; nearly sweet; quality good; season August 16 to 22 in 1910.

Llewellyn.—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, roundish, flattened opposite suture side, small; suture to apex, a line; apex rounded with a minute point; color dull greenish, mottled with dull red and streaked carmine, overcast with gray, dull colored; skin thick, tough, downy; flesh white, deep carmine next to skin, juicy, fibrous, meaty; stone cling, large, elliptical pointed, thick; flavor mild subacid; quality fair; ripened August 27 in 1910.

Lola (*Miss*),—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands orbicular; fruit uniform, roundish, flattened at ends, lopsided, medium; suture to apex, shallow; apex rounded; color rich yellow with rich dark red over entire surface, very attractive; skin thick, tough, slightly downy; flesh rich yellow, red at stone, juicy, meaty; stone free, large, roundish with short point; flavor rich, sweet, spicy; quality good; season July 27 to August 4 in 1910.

Lorentz,—Tree a little spreading, vigorous, stock; bark smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf medium size, long, medium to wide, very finely serrated, crinkled, glands reniform; fruit uniform, roundish, sides unequal, lopsided, large; suture to apex, shallow; apex rounded with a small point; color rich yellow mottled and blushed with bright and dark red, rather attractive; skin thick, moderately tender, downy; flesh yellow, tinged red, red at stone, rather dry, fibrous, meaty; stone free, moderately large, obovate with tip, one side undeveloped, thick; flavor nearly sweet, not much character; quality fair; very productive; season September 17 to 23 in 1910:

Lovett ('s White),—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium size, long, narrow, serrated, glands reniform; fruit uniform, oblong, lopsided, flattened toward apex, medium size; suture to apex, shallow; apex rounded; color greenish yellow with rich blush; skin nearly smooth, thick, tough; flesh white, tinged with red, red at stone, moderately juicy, meaty; stone cling, large, oblong, pointed at ends; flavor sweet, pleasant; quality fair; season August 5 to 15 in 1910.

Lyon,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf crinkly, medium large, long, rather narrow, finely serrated, glands reniform; fruit medium size, uniform; roundish, lopsided, flat at base, sides often unequal; suture to apex, a line; apex a small point; color bright yellow with rich deep blush, very attractive; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, medium large, nearly oblong, very thick, long point, coarsely pitted; flavor pleasant, rich, spicy, very good; very productive, a good late market sort; season September 3 to 21 in 1910.

Mamie Ross,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs moderately bright; foliage abundant, healthy, dark green; leaf large, long, rather broad, serrated, glands reniform; fruit uniform, drops badly, some rot, roundish, somewhat truncate, above medium size; suture to apex, shallow; apex truncate, roundish; color creamy white, blotched and blushed with red; skin moderately thick, rather tough, downy; flesh white, streaked red, white at stone, very melting, juicy, fine; stone free, medium, oval pointed; flavor mild pleasant subacid; quality very good; ripened July 24 in 1910.

Mammoth Heath,—Tree spreading, vigorous, stocky; bark rough, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, crinkled, finely serrated, glands orbicular; fruit uniform, free from disease, roundish, a little pointed, sometimes slightly oblong, rather large; suture to apex, deep or shallow; apex rounded or pointed; color cream with thin blush; skin thin, tough, downy; flesh white, tinted red at stone, juicy, meaty; stone cling, oblong, wide at center, small point, thick, finely pitted; flavor nearly sweet; quality good; season September 12 to 21 in 1910.

Marshall,—Tree erect spreading, vigorous, stocky; bark nearly smooth, color bright, twigs bright; foliage abundant, healthy, light green; leaf small to medium, long, narrow, finely serrated, glands reniform; fruit medium size, uniform roundish, sides often unequal, flattened a little at ends; suture beyond apex, a line; apex rounded; color rich yellow with bright heavy blush, rather attractive, skin thick, tough, downy; flesh yellow, red at stone, melting, moderately juicy, meaty; stone free, very large, broad oblong, small tip, very thick, coarsely pitted; flavor pleasant, spicy; quality very good; productive, a good late sort; season September 2 to 15 in 1910.

Mathews (Beauty),—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, glands orbicular; fruit uniform, roundish, flattened at sides especially toward apex, large; suture to apex, a line; apex rounded with minute point; color dull yellow, one-half covered with rich red, not very attractive; skin thick, tough, downy; flesh yellow, juicy, fibrous, meaty; stone free, very large, obovate with one lower edge drawn in, thick, coarsely pitted; flavor pleasant, spicy; quality good; season August 21 to September 8 in 1910.

May Lee (*Cling*),—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to wide, crinkled, coarsely serrated, glands reniform; fruit uniform, roundish, often tapering to both ends, sides often unequal, medium: suture to apex or beyond, shallow; apex rounded; color pale yellow partially washed or mottled with dull red; skin thick, tough, downy; flesh light greenish yellow, tinged red, juicy, fibrous; stone free to semi-cling, medium, obovate, small point, thick, coarsely pitted; flavor thin, watery; quality poor; season June 26 to July 8 in 1910.

McCollister,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, narrow to wide, finely serrated, glands reniform; fruit moderately large, uniform, roundish, slight tip; suture to apex, a line; apex pointed; color rich yellow, bright blush, very attractive; skin thin, tough, downy; flesh rich yellow, red at stone, melting, moderately juicy, fibrous; stone free, large, elliptical, long point, thick, coarsely pitted; flavor pleasant mild subacid, spicy; quality very good; season September 1 to 10 in 1910.

McIntosh,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright, foliage abundant, healthy, dark green; leaf moderately large, long, narrow to moderately wide, serrated, glands reniform; fruit uniform, roundish, sometimes oblong, sometimes flattened, medium size; suture to apex, shallow; apex rounded; color pale yellow, rich red blush and mottling; skin thick, tough, somewhat downy; flesh white, slightly tinged with red, red at stone, juicy, fibrous; stone free, small, elliptic with point, thick, smoothly pitted; flavor pleasant, nearly sweet; quality good; season July 14 to 28 in 1910.

Miller,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf medium, long, mostly narrow crinkled, finely serrated, glands reniform; fruit uniform, roundish, tapering to apex, flattened on suture side, medium to large; suture to apex, a line; apex pointed; color dull greenish yellow, mottled dull red with streaks of carmine, heavy gray down gives marked silvery-gray appearance; skin thick, very tough, very downy; flesh white, tinged with red especially toward skin, slightly red at stone, juicy, fibrous, meaty; stone free, large, roundish with very long tapering point, thick; flavor mild subacid; quality fair; season August 27 to September 7 in 1910.

Monstrous (*Pompone*),—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf moderately large, long, narrow, crinkled, serrated, glands orbicular; fruit uniform, roundish, slightly bulged on suture side, sides somewhat unequal, above medium size; suture to apex, a line; apex rounded, minute point; color pale yellow mottled with bright and dark red, not attractive; skin thick, tough, downy; flesh white, red at stone, juicy, fibrous; stone cling, large, obovate with point, thick; flavor nearly sweet, pleasant; quality good; season August 15 to 24 in 1910.

Moore (*Favorite*),—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, glands orbicular; fruit uniform, free from disease; roundish, sides unequal, sometimes flattened opposite suture, large; suture to apex, a line; apex rounded with small point; color pale yellow, mostly covered with thin bright red mottling, heavily blushed; skin thick, tough, downy; flesh white, tinted red, red at stone, juicy, fibrous, meaty; stone free, large, broadly elliptical, pointed, somewhat flat, truncate at base; flavor sweet, rich; quality good; season August 15 to 18 in 1910.

Morris White.—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, rather wide, serrated, glands reniform; fruit uniform; medium size, some scab, roundish, lopsided, sometimes flattened on suture side, sides often unequal; suture to apex, a line; apex rounded, a small point; color creamy white with small thin blush, not attractive; skin thick, tough, slightly downy; flesh white, white at stone, moderately juicy, fibrous, meaty; stone free, large, nearly elliptical with point, thick, coarsely pitted; flavor sweet, rather tasteless; quality fair; season August 23 to 29 in 1910.

Mountain Rareripe,—Tree erect spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to wide, serrated, glands orbicular; fruit round, medium size; suture to apex, a line; apex rounded; color pale yellow, rich blush; skin moderately thick, tough, somewhat downy; flesh yellowish white, melting, juicy, fine, fibrous, red at stone; stone free, very large, roundish oblong, very thick; flavor pleasant, spicy, nearly sweet; quality excellent; season August 13 to 20 in 1910.

Mountain Rose.—Tree spreading, vigorous, stocky; bark moderately smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands orbicular; fruit uniform, roundish, one side much larger than the other, medium to above in size; suture to apex, a line; apex rounded; color creamy with rich blush, very attractive; skin thick, tough, somewhat downy; flesh white, red at stone, melting, juicy, fibrous; stone free, large, obovate with short point; flavor sweet, spicy, rich; quality excellent; season August 5 to 22 in 1910.

Nixe (Nix Late).—Tree spreading, vigorous, stocky; bark moderately rough, bright, twigs green; foliage abundant, healthy, dark green; leaf medium size, moderately long, narrow to moderately wide, serrated, glands reniform; fruit uniform, roundish, medium to large; suture to apex, shallow; apex rounded; color yellow with bright heavy red and mottling, attractive blush over half of surface; skin thick, tough, downy; flesh rich yellow, red at stone, melting, juicy, fine, meaty; stone free, very large, nearly round, broad, very thick, roughly pitted; flavor nearly sweet, very pleasant, rich; quality good; ripened August 30 in 1910.

October Elberta,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, mostly light green; leaf large, long, broad, crinkled, serrated, glands reniform; fruit uniform, a little rot, drops considerably, oblong pointed, medium size; suture to apex, a line; apex pointed; color pale yellow with bright blush; skin thick, tough, somewhat downy; flesh creamy, red at stone, juicy, meaty; stone cling, large, narrow, elliptical, pointed, thick, coarsely pitted; flavor pleasant, mild subacid; quality fair; ripened August 30 in 1910.

Oldmixon.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium, long, narrow to broad, serrated, glands orbicular; fruit uniform, roundish, sides unequal, medium to large; suture beyond apex, moderately shallow; apex rounded with small point; color pale yellow, mottled and blushed bright and dark red and dull purplish stripes; skin thick, tough, downy; flesh white, red at stone, melting, juicy, fibrous, meaty; stone free, large, roundish-obovate, moderately thick, smoothly pitted; flavor mild pleasant subacid, nearly sweet, spicy; quality good; season August 26 to September 3 in 1910.

Opulent,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, medium size, roundish, tapering toward apex, flattened at base; suture to apex, shallow; apex rounded; color greenish white with rich blush; skin thin, tough, somewhat downy; flesh white, melting, juicy, meaty; stone free, large, oblong with point, thick; flavor nearly sweet, spicy, sprightly; quality good; season August 2 to 3 in 1910.

Orange Free,—Tree spreading, vigorous, stocky; bark a little rough, bright, twigs almost green; foliage abundant, healthy, rather light green; leaf medium, size long, narrow to wide, serrated, glands orbicular; fruit uniform, medium size, some rot, roundish with point; suture to apex, a line; apex pointed; color pale yellow with thin bright mottled blush; skin thick, tough, downy; flesh white, red at stone, juicy, fine; stone free, large, obovate with long point, thick, coarsely pitted; flavor sweet, spicy, rich; quality good; season August 22 to 27 in 1910.

Oriole,—Tree spreading, vigorous, stocky; bark rough, dull, twigs green, foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, finely serrated, glands reniform; fruit uniform, roundish tapering to apex, medium to large; suture to apex, a line; apex a small point; color very pale yellow, thinly blushed and mottled with red; skin thick, tough with very short down; flesh greenish white, red at stone, juicy, fibrous, meaty; stone free, medium size, elliptical with long tapering point, thick, finely pitted, rough; flavor rather mild subacid, vinous; quality fair to good; ripened September 13 in 1911.

Oscar.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands orbicular; fruit uniform, some rot and scab, roundish, medium size; suture to apex or beyond, moderately deep; apex rounded; color creamy white mottled and blushed dark red; skin moderately thick, tough, downy; flesh greenish white, red at stone, somewhat melting, juicy; stone cling or semi-free, large, roundish, thick; flavor subacid; quality fair; season July 17 to 28 in 1910.

Oxford Cling,—Tree spreading, moderately vigorous, stocky; bark rough, bright, twigs bright; foliage abundant, healthy, light green; leaf medium to large, long, wide, somewhat crinkled, finely serrated, glands reniform; fruit uniform, medium size, roundish, irregular, pointed, sometimes flattened, sides often unequal; suture to apex, a line; apex pointed; color pale yellow sometimes almost entirely mottled and blushed with bright or dark red; skin thick, tough, downy; flesh creamy, tinged red, red at stone, juicy, meaty; stone cling, large, elliptical with small point, thick, coarsely pitted; flavor nearly sweet; quality fair; ripened August 30 in 1910.

Palmerston.—Tree erect, spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately broad, serrated, glands orbicular; fruit uniform, rounded, sides unequal, sometimes lopsided, medium to above; suture beyond apex, shallow; apex a small point; color pale creamy white with delicate pink blush and mottling; skin thick, tough, downy; flesh white, red at stone, juicy, meaty; stone cling, medium size, oval, thick; flavor mild subacid; quality good to excellent; ripened August 21 in 1910.

Peento.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands reniform; fruit uniform, much subject to rot, flat, small to medium; suture to apex, shallow; apex hollow;

color dull yellow with bright blush; skin nearly smooth, thick, tough; flesh white, juicy, meaty; stone cling, medium, roundish; flattened at ends, pitted; flavor sweet; quality fair; season July 30 to August 5 in 1910.

Persis.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, serrated, glands reniform; fruit large, uniform, roundish, lopsided, sides unequal, sometimes with slight tip; suture to apex, a line; apex rounded; color light yellow shaded and mottled with bright and dull red, attractive; skin thin, tough, downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, large obovate, lopsided, sides unequal, thick, coarsely pitted; flavor rich mild subacid, nearly sweet; quality very good; season August 29 to September 5 in 1910.

Pickett Late.—Tree erect, vigorous, stocky; bark a little rough, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, narrow to wide, finely serrated, crinkly, glands reniform; fruit large, uniform, roundish, sides unequal, flattened at ends; suture to apex, shallow; apex rounded; color yellow, with bright red and scarlet mottling; skin thick, tough, downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone semi-cling, large, broadly ovate, thick, small tip, coarsely pitted; flavor nearly sweet, vinous, quality very good; season September 16 to 20 in 1910.

Plant,—Tree erect, vigorous, stocky; bark a little rough, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, wide, crinkled, coarsely serrated, glands reniform; fruit uniform, roundish, sometimes flattened at end, medium to above in size; suture to apex, shallow; apex rounded; color rich yellow with rich red mottling and blush; skin thick, tough, downy; flesh rich yellow, juicy, meaty; stone cling, very large, roundish with point, thick; flavor spicy; quality good; season August 28 to September 8 in 1910.

Poole Favorite.—Fruit roundish-conic, medium size; suture to apex, shallow; apex pointed; color yellow mottled and blushed with red; skin thin, tough, downy; flesh yellow, purplish red at stone, melting, juicy, meaty, tender; stone free, medium size, oval, thick; flavor rich subacid; quality very good; season September 9 to 23 in 1910.

Price Late.—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, light green; leaf medium size, long, narrow, serrated, glands orbicular; fruit uniform, medium size, roundish-oblong, sides unequal; suture beyond apex, shallow; apex rounded with a minute tip; color pale yellow mottled with bright and purplish red; skin thick, tough with considerable down; flesh white tinged with red, red at stone, moderately juicy, fibrous; stone free, large, long obovate with small point, thick, coarsely pitted; flavor mild subacid; quality fair; ripened September 5 in 1911.

Prolific.—Tree somewhat spreading, moderately vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to wide, serrated, glands orbicular; fruit nearly uniform, roundish, lopsided, medium size; suture to apex, a line; apex rounded; color yellow with faint blush; skin thin, tender, somewhat downy; flesh yellow, red at stone, juicy, fine, meaty; stone free, large, nearly round with small point, thick; flavor sweet, spicy, pleasant; quality good; season August 7 to 15 in 1910.

Pry (Favorite),—Tree spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, somewhat diseased, light green, crinkled; leaf medium size, long, moderately narrow, finely serrated, glands reniform;

fruit uniform, medium to large, roundish tapering toward apex, sides sometimes compressed; suture to apex, shallow; apex pointed; color pale yellow mottled with thin bright red especially around cavity; skin thick, tough with considerable down; flesh yellow, red at stone, moderately juicy, meaty; stone free, small, lopsided oval with long point, thick, coarsely pitted; flavor pleasant subacid; quality fair; ripened September 15 in 1911.

Ray,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright, foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands orbicular; fruit uniform, roundish, sides unequal, medium size; suture to apex, a line; apex rounded; color creamy, rich bright blush, rather attractive; skin moderately thick, tough, considerably downy; flesh white, tinged red, red at stone, juicy, fibrous; stone free, large, obovate, lopsided with small point; flavor mild subacid, watery, slightly bitter; quality poor; season August 6 to 10 in 1910.

Red Bird Cling,—Tree spreading, vigorous, stocky; bark moderately smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, coarsely serrated, glands reniform; fruit uniform, roundish-oblong, often with double appearance caused by deep suture, often flattened on suture and opposite sides, very large; suture sometimes clear around fruit, very deep; apex rounded; color very pale rich yellow, partially mottled and blushed with rich red and striped with rich light and dark red, very attractive; skin thick, tough, downy; flesh pale yellow, sometimes heavily tinged with red, juicy, very meaty; stone cling, very large, roundish in outline with small point, thick, smoothly pitted, often split; flavor mild subacid, rather pleasant; quality fair; season June 26 to July 8 in 1910.

Red Cheek (Melocoton),—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf large, long, moderately broad, crinkled, serrated, glands orbicular; fruit moderately uniform, roundish-oblong, bulged on suture side at apex, sides unequal, medium to large; suture beyond apex, moderately deep; apex rounded with small point; color yellow mottled and blushed light and dark rather bright red, carmine stripes; skin thick, moderately tough, very downy; flesh yellow, tinged with red, red at stone, melting, juicy, fibrous, meaty; stone free, large, obovate with point, moderately thick, coarsely pitted; flavor mild subacid, nearly sweet; quality good; season August 24 to 30 in 1910.

Red Cling.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands orbicular; fruit uniform, roundish, suture side slightly bulged, medium size; suture beyond apex, very shallow; apex a minute point; color dull yellow, blushed, not attractive; skin thick, tough, downy; flesh yellow, red at stone, juicy, fibrous, meaty; stone free, large, obovate with distinct point, very thick; flavor subacid; quality fair; season August 15 to September 6 in 1910.

Red Georges (Georgia?),—Tree spreading, vigorous, stocky; bark somewhat rough, twigs bright; foliage abundant, healthy, dark green; leaf large long, broad, crinkled, serrated, glands reniform; fruit uniform, free from disease, roundish, sometimes pointed, sides unequal, medium size; suture to apex, a line; apex rounded; color greenish yellow with dull carmine stripes and some mottling, clouded with grey; skin thick, tough, very thick silvery down; flesh mottled red and white, moderately juicy, meaty; stone cling, large, obovate, very thick, finely pitted; flavor pleasant subacid; quality fair; ripened August 30 in 1910.

Red River,—Tree erect, vigorous, stocky; bark rough, dull, twigs green; foliage abundant, healthy, dark green; leaf large, long, wide, crinkled, coarsely serrated, glands reniform; fruit uniform, roundish, enlarged on suture side, often unequal, slightly flattened at ends, medium or smaller, suture to apex, shallow; apex rounded; color pale yellow, partly washed and mottled with bright red, blushed; skin thin, moderately tough, somewhat downy; flesh creamy, juicy, fibrous; stone free, medium, long obovate with slight point, thick, coarsely pitted; flavor pleasant, almost sweet; quality fair; season July 19 to 23 in 1910.

Reeds Late Barnard,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately broad, serrated, glands orbicular; fruit round, a little lopsided, small to medium; suture around fruit, moderately deep; apex a slight point; color yellow entirely covered with dull red; skin thick, tough, downy; flesh rich yellow tinged with red, red at stone; moderately juicy, meaty; stone free, large, obovate, broad base, pointed; flavor delicate, spicy, sweet; quality excellent; season August 1 to 15 in 1910.

Reeves,—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, rather wide, serrated, glands orbicular; fruit uniform, roundish-oval with small point, sides unequal, above medium to large; suture beyond apex usually rather shallow; color rich yellow, marbled and blushed with rich red; skin moderately thick, tough, downy; flesh rich yellow, red at stone, melting, juicy, fibrous, meaty; stone free, small, roundish, pointed, thick; flavor mild rich subacid, nearly sweet, spicy; quality excellent; season August 13 to 22 in 1910.

Ring,—Tree erect, vigorous, stocky; bark nearly smooth, bright, twigs bright; foliage abundant, healthy, dark green, leaf medium to large, long, narrow to wide, serrated, glands reniform; fruit large, uniform, oblong, considerably lopsided, sides unequal, somewhat flattened at sides; suture to apex, a line; apex rounded with slight point; color rich yellow with rich red and mottled cheek, very highly colored, attractive; skin thick, tough, downy; flesh yellow, red at stone, juicy, fibrous, meaty; stone free, very large, oblong-obovate, flat; flavor rich mild subacid, spicy; quality excellent; apparently splendid for market; season August 15 to 25 in 1910.

Robert G. Nectar,—Tree erect, vigorous, stocky; bark smooth, bright, twigs green; foliage abundant, healthy, dark green; leaf moderately large, long, narrow, serrated, glands reniform; fruit uniform, roundish to oblong, sides unequal, often lopsided, medium size; suture beyond apex, shallow; apex rounded with small point; color creamy with indication of a blush; skin thick, tough, considerably downy; flesh creamy-white, juicy, tender, fibrous; stone free, large obovate, rather flat, coarsely pitted and rather rough; flavor mild subacid, bitterish; quality poor; ripened August 29 in 1910.

Roser,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, wide, crinkled, serrated, glands reniform; fruit uniform, roundish, sometimes a little oblique, medium size; suture to apex, a line; apex rounded with minute point; color yellow with bright red blush and mottling; skin thick, tough, somewhat downy; flesh rich yellow, juicy, meaty; stone cling, large, oblong, lopsided with blunt point, thick, coarsely pitted; flavor nearly sweet, spicy; quality good; season August 28 to September 8 in 1910.

Ruding,—Tree erect, spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, wide, serrated, glands reniform; fruit uniform, large round, flattened at ends, sides often unequal; suture beyond apex, a line; apex a small point, rounded; color light yellow with thin rich blush; skin thick, tough, somewhat downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, very large, obovate, very thick; flavor rich mild subacid, spicy, quality excellent; apparently a desirable commercial variety; season August 13 to 25 in 1910.

Russell Nebraska,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow, serrated, glands orbicular; fruit uniform, medium size, roundish, lopsided, flattened at base, often flattened at sides; suture to apex, shallow; apex rounded; color yellow with dark red blush and mottling; skin moderately thick, moderately tender, downy; flesh white, stained red, red at stone, juicy, meaty; stone free, medium, nearly round with point; flavor pleasant, nearly sweet; quality good; season July 31 to August 10 in 1910.

Saint John,—Tree spreading, vigorous, stocky; bark rough, dull, twigs green; foliage abundant, healthy, dark green; leaf large, long, narrow to wide, crinkled, finely serrated, glands orbicular; fruit uniform, sides some times unequal, flattened at ends, medium size; suture beyond apex, moderately deep; apex rounded; color rich yellow, washed and mottled with rich light and dark red, very attractive; skin smooth, thin, rather tender; flesh rich yellow, red at stone, juicy, tender, fibrous, meaty; stone free. large, roundish with point, thick, coarsely pitted; flavor mild subacid, pleasant, nearly sweet; quality good; season July 24 to 28 in 1910.

Salway,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to wide, coarsely serrated, glands reniform; fruit unifom, medium or above, globular; suture to apex, shallow; apex rounded with minute point; color rich yellow with heavy rich red blush or mottling; skin medium thick, tough, covered with short down; flesh rich yellow, red at pit, juicy, tender, meaty; flavor rich, pleasant subacid; quality good; pit medium size, free, elliptical with short point, thick; season first half of October.

Sawyer,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow, coarsely serrated, glands reniform; fruit uniform, roundish, a little lopsided, sides unequal, large to very large; suture beyond apex, shallow; apex rounded; color pale yellow washed and mottled with light and dull red; skin thick, tough, slightly downy; flesh yellow, red at stone, rather dry, meaty; stone free, medium size, obovate, with very short point, thick, finely pitted, rough; flavor faintly mild subacid, nearly sweet; quality fair; ripened September 13 in 1911.

Schumaker,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright, foliage abundant, healthy, dark green; leaf medium size, long, narrow, serrated, glands reniform; fruit roundish, somewhat lengthened from base to apex, sides unequal, often lopsided, medium size; suture to apex, a line; apex pointed; color pale yellow often entirely covered with bright heavy red; skin thick, tender with heavy down; flesh white, tinged red, red at stone, melting, rather dry, fibrous; stone free, medium size, obovate, thick, finely pitted, smooth; flavor slightly subacid, nearly sweet; pleasant; quality fair; ripened August 25 in 1910.

Scott,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf crinkly, large, long, narrow, finely serrated, glands orbicular; fruit large, uniform, almost free from disease, round, sides often unequal, sometimes flattened at sides; suture to apex, very shallow; apex rounded; color pale yellow with rich red cheek; skin thick, tough, somewhat downy; flesh rich yellow, red at stone, juicy, fibrous, meaty; stone free, large, oblong, considerable point, very thick, coarsely pitted; flavor rich, nearly sweet; quality very good; season August 26 to September 5 in 1910.

Shipley,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands orbicular; fruit uniform, somewhat scabby, roundish, somewhat flattened on sides toward apex, medium to large; suture to apex, a line; apex rounded with a minute point; color pale yellow with thin blush or mottling of bright red, skin thick, rather tender, downy; flesh white, tinged with red, red at stone, juicy, fibrous, meaty; stone free, large, broadly elliptical, thick; flavor pleasant mild subacid, nearly sweet; quality good; season August 26 to 29 in 1910.

Silver Medal,—Tree erect, very vigorous, stocky; bark nearly smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf large, long, broad, finely serrated, glands orbicular; fruit uniform, roundish-oblong, sides unequal, medium to nearly large; suture to apex, shallow; apex rounded with small point; color creamy with a little light bright blush; skin thick, tough, downy; flesh white, slightly tinted red at stone, rather dry and mealy, fibrous; stone free, large, obovate with long point, thick, coarsely pitted; flavor nearly sweet, a little vinous; quality fair; season September 2 to 13 in 1910.

Slappy,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, crinkled, serrated, glands reniform; fruit uniform, oval-pointed, lopsided, flattened toward apex, medium size; suture beyond apex, shallow; apex pointed; color yellow, blushed slightly along suture; skin thick, slightly downy; flesh yellow, red at stone, moderately juicy, meaty; stone free, large, oblong with long point; flavor mild subacid; quality good; season July 28 to August 2 in 1910.

Smith Yellow,—Tree erect, vigorous, stocky; bark nearly smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long wide, crinkly, finely serrated, glands orbicular; fruit shaped like Crawford Late but more pointed, medium large; suture to apex, shallow; apex pointed; color rich yellow, shaded and mottled with bright and dark red; skin thick, tough, downy; flesh rich yellow, juicy, red at stone; stone free, medium, obovate, a little lopsided, thick, small point; flavor rich, spicy, nearly sweet; quality excellent; very attractive and productive, apparently good for market; season August 27 to September 8 in 1910.

Sneed,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, wide, coarsely serrated, glands reniform; fruit uniform, roundish-oblong to roundish-oval, medium size; suture to apex, moderately deep; apex rounded; color greenish white with thin blush and mottling; skin moderately thick, tough with long, loose down; flesh greenish white tinged with red, stained red at skin, juicy, fibrous; stone cling or semi-cling, medium size, oval with long narrow point, thick; flavor mild subacid; quality fair to good; season June 16 to 18 in 1910.

Snow Orange,—Tree erect, vigorous, stocky; bark rough, bright, twigs bright; foliage abundant, healthy, light green; leaf medium long, narrow, slightly crinkled, finely serrated, glands reniform; fruit not uniform, roundish, sides unequal, flattened, medium size, suture beyond apex, deep; apex a small point; color dull yellow washed and mottled with bright and dull red; skin thick, tender, downy; flesh rich yellow tinged with red, red at stone, moderately juicy to rather dry, fibrous; stone free, large, obovate with point, thick, coarsely pitted; flavor mild subacid, rather sweet; quality fair; season August 6 to 16 in 1910.

Steadley,—Tree erect, vigorous, stocky; bark moderately smooth, bright. twigs bright; foliage abundant, healthy, dark green; leaf medium size, long, narrow to moderately wide, finely serrated, glands reniform; fruit uniform, roundish-obovate, sides unequal and somewhat compressed toward base and apex, a little lopsided, medium to large; suture three-fourths around fruit, shallow; apex rounded with a minute point; color pale yellow with a little mottling of red; skin thin, moderately tough with considerable down; flesh creamy, juicy, tender, a little fibrous; stone free, medium size, obovate with considerable tip, thick, very coarsely pitted; flavor nearly sweet, pleasant; quality fair; ripened September 20 in 1911.

Stump,—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad. serrated, glands orbicular; fruit uniform, roundish, slightly oblong, sides unequal, medium; suture beyond apex, a line; apex rounded with a very small point; color pale yellow, blushed with bright red over nearly the entire fruit; skin thick, tough, downy; flesh rich white, tinted red, red at stone, melting, juicy, fibrous; stone free, large, narrow, obovate with considerable point, rather flat; flavor pleasant subacid; quality good; season August 13 to 29 in 1910.

Sunrise (*Cling*),—Tree erect, vigorous, stocky; bark a little rough, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium to large, long, medium to wide, finely serrated, crinkled, glands orbicular; fruit uniform, roundish, sides often unequal and lopsided, medium to above; suture beyond apex, shallow; apex rounded with small point; color cream with bright red blush; skin thin, tough, downy; flesh white, juicy, fine, meaty; stone cling, large, oval; flavor pleasant, sweet; quality good to very good; season September 10 to 23 in 1910.

Susquehanna,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, serrated, glands reniform; fruit uniform, roundish, suture side prominent, flattened at base, large; suture to apex, a line; apex rounded; color yellow, blushed with bright and heavy red, very attractive; skin thick, tough, downy; flesh rich yellow, slightly red at stone, juicy, fibrous, meaty; stone semi-cling, very large, obovate with point, thick; flavor pleasant, spicy; quality good; season August 13 to 20 in 1910.

Switzerland,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green, crinkled; leaf medium to large, long, medium wide, finely serrated, glands reniform; fruit uniform, round, medium size, sides often unequal; suture to apex, a line; apex a minute point, rounded; color pale yellow with dark blush and bright mottling; skin thin, tough, downy; flesh white, tinged with red, juicy, red at stone; stone free, large, obovate, considerable point, thick, coarsely pitted; flavor rich, spicy, nearly sweet; quality excellent; season August 30 to September 13 in 1910.

Sylphide,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately broad, serrated, glands reniform; fruit uniform, roundish, sides somewhat unequal, small; suture to apex, a line; apex rounded with minute point; color pale yellow, mottled and blushed with bright red; skin thick, tough, downy; flesh white, juicy, fibrous, meaty; stone cling, large, broadly elliptical, very thick; flavor sprightly subacid; quality very good; season August 26 to 30 in 1910.

Thurber,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide. serrated, glands orbicular; fruit uniform, roundish, slightly oblong, a little lopsided, medium; suture to apex, a line; apex rounded; color creamy with small bright blush, rather attractive light color; skin thick, tough, somewhat downy; flesh white, tinted red, red at stone; juicy, fibrous; stone free, large, long, obovate, flat; flavor mild subacid, watery; quality fair; season August 12 to 19 in 1910.

Triumph,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands orbicular; fruit uniform, roundish, flattened at ends, small, suture to apex or beyond, moderately deep; apex rounded; color cream with rich blush turning to dark red; skin thin, tough, slightly downy; flesh white, melting, juicy, fibrous; stone free; flavor mild subacid; quality fair; season July 30 to August 4 in 1910.

Troth,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, rather broad, serrated, glands orbicular; fruit uniform, roundish, sides usually unequal, sometimes compressed, a little lopsided, flattened at base, medium size; suture to apex, shallow; apex rounded; color greenish yellow with beautiful blush; skin smooth, thick, tough; flesh white, red at stone, melting, moderately juicy, meaty; stone free, large, obovate with blunt point, moderately thick, roughly pitted; flavor nearly sweet, spicy; quality good; season August 1 to 13 in 1910.

Turner,—Tree erect, vigorous, stocky; bark rough, dark, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf large, long, narrow to broad, serrated, glands reniform; fruit uniform, roundish, often enlarged on suture side, sides often unequal, slightly pointed, medium or above; suture to apex, a line; apex pointed; color rich yellow mostly washed and mottled with bright and dark red, very attractive; skin thick, tough, downy; flesh rich yellow, red at stone, melting, juicy, fibrous, meaty; stone free, large, obovate with considerable point, very thick, coarsely pitted; flavor rich mild subacid, spicy; quality good; productive, probably good for market; season August 16 to 31 in 1910.

Tyhurst.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf moderately large, long, narrow, serrated, glands reniform; fruit uniform, roundish sides, slightly unequal, flattened at ends, medium size; suture to apex or beyond, moderately deep; apex rounded with small point; color yellow, mottled with bright and dark red; skin thick, tough, very downy; flesh light yellow, red at stone, rather dry, fibrous, meaty; stone free, moderately large, obovate with sharp point, thick; flavor mild subacid; quality fair; season August 25 to 29 in 1910.

Uneeda (Cling),—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, rather broad, serrated, glands orbicular; fruit uniform, square in outline, flattened on suture side and on sides at apex, medium or above in size; suture entirely around fruit, shallow; apex slightly pointed; color pale yellow, thin bright blush; skin thick, tender; flesh white, rather dry, meaty; stone cling, often split, large, roundish; flavor mildly subacid, flat; quality fair; season August 2 to 10 in 1910.

Van Meter ('s Late),—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf medium to large, long, broad, finely serrated, glands reniform; fruit uniform, roundish, lopsided, sides unequal, sometimes flattened on suture side and at base, medium size; suture beyond apex, shallow; apex pointed; color yellow, mottled with rich and dark red; fairly attractive; skin thick, tough, somewhat downy; flesh rich yellow, red at stone, moderately juicy, meaty;

stone free or semi-cling, large, nearly round, considerable tip, thick, coarsely pitted; flavor pleasant, nearly sweet; quality fair; productive; season September 16 to 23 in 1910.

Victor,—Tree erect, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf medium, moderately long, moderately narrow, coarsely serrated, glands reniform; fruit uniform, roundish, slightly flattened at ends, flattened sides, small to medium; suture to apex, deep, apex rounded; color pale yellow, mottled rich red, dark blush; skin thick, tough, downy; flesh white, tinged with red, melting, moderately juicy, fibrous, meaty; stone semi-cling to cling, small, ellipse with slight point, flat, smoothly pitted; flavor mild subacid, nearly sweet, a little spicy; quality fair; ripened June 16 in 1910.

Waddell,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright: foliage abundant, healthy, dark green; leaf large, long, narrow to moderately wide, serrated, glands reniform; fruit uniform, rotted badly, roundish, slightly compressed to oblong flattened, sides unequal, medium to large; suture to apex or beyond, shallow; apex rounded with small point; color creamy with light and dark carmine beautifully mottled; skin thin, moderately tough, slightly downy; flesh white, tinted with red, white at stone, melting, juicy, fine, meaty, a little fibrous; stone free, large, roundish-pointed to oblong-pointed, thick, flavor mild subacid, spicy; quality fair to good; season July 26 to August 2 in 1910.

Wager,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf medium size, long, narrow, serrated, glands reniform; fruit uniform, roundish, suture side compressed, lopsided, small; suture to apex, a line; apex rounded; color rich yellow, heavy red blush, rich mottling, attractive; skin thick, tough, downy; flesh rich yellow, red at stone, moderately juicy, fine, meaty; stone free, medium, obovate with point thick; flavor pleasant subacid; quality good; season August 10 to 12 in 1910.

Walker,—Tree spreading, vigorous, stocky; bark rather rough, dull, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated, glands orbicular; fruit uniform, roundish, sides sometimes unequal, often tapering toward apex, medium to large, suture to apex, shallow; apex rounded with a minute point; color creamy white, sometimes with bright red mottling or heavy blush over most of surface, attractive; skin thick, tough, downy; flesh white, tinged red, red at stone, juicy, fibrous; stone free, large, obovate, pointed, thick; flavor pleasant, nearly sweet; quality good; ripened August 24 in 1910.

Wards Late,—Tree spreading, vigorous, stocky; bark rough, dull; foliage moderately abundant, healthy, light green; leaf moderately large, long, medium width, serrated, glands reniform; fruit medium size, roundish, sides unequal; suture beyond apex, a line; apex rounded; color yellow with rich deep red over entire fruit, attractive rich color; skin thick, tender, fuzzy; flesh very rich yellow, tinged with red, red at stone, melting, moderately juicy, fine grained, meaty; stone free, large, elliptical with point, thick; flavor mild subacid, nearly sweet, pleasant; quality very good; season August 8 to 20 in 1910.

Weaver,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf medium, long, narrow to wide, crinkled, finely serrated, glands orbicular; fruit uniform, roundish with considerable point, sides unequal, a little lopsided, above medium; suture to apex, shallow; apex pointed; color yellow with red blush; skin thick, tough, downy; flesh rich yellow tinged with red, red at stone, moderately juicy, fibrous; stone cling, very large, obovate with long point, very thick, coarsely pitted; flavor pleasant rich subacid, nearly sweet; quality good; ripened September 8 in 1910.

Wheeler ('s Late),—Tree erect, vigorous, stocky; bark rough, bright, twigs bright; foliage abundant, healthy, light green; leaf medium, moderately long, narrow, crinkled, finely serrated, glands reniform; fruit uniform, free from disease, roundish, sides unequal, slight tip, medium size; suture to apex, shallow; apex rounded with a small point; color rich yellow with bright heavy mottling, very attractive; skin thick, tough, downy; flesh rich yellow, red at stone, meaty, fibrous; stone free, large, obovate with long tip, thick, coarsely pitted; flavor nearly sweet; quality fair; very productive, probably a good market variety; season September 4 to 13 in 1910.

Wilkins (Cling),—Tree erect, vigorous, stocky; bark rough, bright, twigs bright; foliage abundant, healthy, light green; leaf medium to large, long, narrow to wide, crinkled, finely serrated, glands reniform; fruit uniform, roundish, sides unequal, medium size; suture beyond apex, deep; apex rounded, a small point; color yellow, heavy bright blush, very attractive; skin thick, tough, downy; flesh yellow, juicy, meaty; stone cling, very large, obovate, broad at base, small point, very thick, coarsely pitted; flavor nearly sweet, pleasant; quality fair; season August 26 to September 13 in 1910.

Williams Cling,—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green, crinkled; leaf medium to large, long, narrow to broad, serrated, glands orbicular; fruit uniform, roundish, sides often unequal, medium to large; suture to apex, a line or shallow; apex rounded with minute point; color pale yellow, shaded and mottled bright rich red; skin thick, tough, downy; flesh creamy white, tinted red, red at stone, juicy, fibrous; stone almost free, large, elliptical, very thick, coarsely pitted; flavor pleasant, spicy; quality fair; ripened August 26 in 1910.

Winnie Davis,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, slightly diseased, light green; leaf large, long, broad, very finely serrated, glands orbicular; fruit uniform, free from disease, nearly round, sides often unequal, medium to above; suture beyond apex, shallow; apex rounded; color greenish white with purplish red blush; skin thick, tough, downy; flesh greenish white, red at stone, melting, juicy, moderately tender; stone semi-cling, large, oval; flavor subacid; quality good; not productive; season October 10 to 20 in 1911.

Wonderful,—Tree somewhat spreading, vigorous, stocky; bark rough, dull, twigs bright; foliage abundant, some disease, light green; leaf small to medium, long, narrow, serrated, glands reniform; fruit uniform, free from disease, roundish, narrowing at base, sides often unequal, medium to large; suture to apex, a line; apex rounded with minute point; color pale yellow, mottled with bright red; skin thin, tough, downy; flesh rich yellow, red at stone, moderately juicy; stone free, very large, obovate with considerable point, thick, coarsely pitted; flavor pleasant mild subacid; quality good; ripened September 1 in 1910.

Woolsey,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, light green; leaf large, long, narrow to broad, serrated, glands orbicular; fruit uniform, roundish, large; suture to apex, a line; apex rounded; color rich yellow, nearly covered with a rich blush, very attractive; skin thin, tough, slightly downy; flesh yellow, red at stone, melting, juicy, fibrous; stone free, large, roundish with short point, thick; flavor pleasant subacid; quality good; season August 6 to 19 in 1910.

Worcester,—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, moderately wide, crinkled, finely serrated, glands reniform; fruit uniform, large, roundish, lopsided, sides sometimes compressed toward apex; suture to apex a line; apex rounded; color rich yellow, very attractive, almost entirely washed and mottled with bright and dark red and purple patches; skin thin, tough with considerable down; flesh rich yellow, slightly tinted red at stone, juicy; stone free, small to medium, obovate with very small point, thick, finely pitted; flavor rich, spicy, sweet; quality excellent: ripened September 13 in 1911; extremely promising.

Worrall (Sallie).—Tree spreading, vigorous, stocky; bark rough, dull, bright; foliage abundant, healthy, dark green; leaf large long, narrow or broad, smooth, serrated, glands reniform; fruit uniform, roundish with point, somewhat tapering to apex, small; suture to apex, very shallow; apex pointed; color rich yellow with rich bright blush or lighter red mottling; flesh rich yellow, red at stone, moderately juicy, fibrous, meaty; stone free, almost round with long point, thick, rather coarsely pitted; flavor very mild subacid, nearly sweet, a little spicy; quality fair; season August 17 to 29 in 1910.

Worth.—Tree spreading, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, serrated; glands reniform, large; fruit uniform, roundish-oblong; sides unequal, flattened at sides, medium; suture to apex, a line; apex rounded; color rich yellow with heavy blush, rather attractive; skin thick, tough, downy; flesh rich yellow, tinged red, red at stone, juicy, fibrous, meaty: stone semi-cling, large, irregular oblong-pointed, flat; flavor mild pleasant subacid, a little bitterish; quality fair; season August 16 to 22 in 1910

Worthen (Jennie).—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, wide, crinkly, finely serrated, glands orbicular; fruit uniform, medium large, round; suture side enlarged, sides unequal, a little flattened at base and apex: suture to apex, a line; apex a minute point, rounded; color rich yellow, washed and mottled with rich bright red; skin thick, tough, somewhat downy; flesh rich yellow, red at stone; juicy, fibrous, meaty; stone free, large, nearly round, considerable point, very thick, coarsely pitted; flavor rich, nearly sweet; quality excellent, productive, ought to be a splendid market sort; season August 23 to 30 in 1910.

Wright Nebraska.—Tree erect, vigorous, stocky; bark smooth, bright, twigs bright; foliage abundant, healthy, dark green; leaf large, long, narrow to broad, somewhat crinkly, serrated, smooth, glands reniform; fruit very large, uniform, free from disease, roundish, slightly flattened, Elberta shaped: suture to apex, a line: apex rounded; color rich yellow, somewhat mottled and blushed with bright red; skin thick, tough, bitter, somewhat downy; flesh rich yellow, tinged with red, red at stone, juicy, fibrous, meaty; stone free, large, one-sided, obovate, thick, smoothly pitted; flavor pleasant mild subacid; quality very good; productive, apparently an extra good market sort; season August 20 to September 15 in 1910.

Wylie (Annie).—Tree erect, vigorous, stocky; bark rough, dark, twigs bright; foliage abundant, healthy, dark green; leaf large, long, broad, sharply saw tooth serrated, crinkled, practically no glands; fruit uniform, somewhat diseased, round, sides unequal, medium large; suture to apex, shallow; apex a slight point, rounded; color pale yellow with rich red blush; skin thick, tough, somewhat downy; flesh white, juicy, tinted red at stone; stone cling, large, obovate with tip, thick, coarsely pitted; flavor pleasant, nearly sweet, vinous; quality good; season September 15 to 19 in 1910.

Yellow Rareripe.—Tree spreading, vigorous, stocky; bark rough, dull, ly wide, crinkled, serrated, glands reniform; fruit uniform, roundish, sides unequal, small; suture beyond apex, deep; apex rounded; color yellow, blushed; skin thin, tender, downy; flesh yellow, tinged with red, moderately juicy, meaty: stone free, large, obovate, lopsided with point; flavor spicy: quality good: season July 28 to August 2 in 1910.

Cost of Growing a Peach Orchard.

It is impossible to get at the exact cost of growing an orchard, and the profits of it, because no one seems to keep an accurate account of the receipts and expenditures of the orchard. We have endeavored to get accurate estimated data on the cost of all orchard operations, the net returns, varieties grown, soils used, etc., by sending out scores of letters of inquiry to the largest peach growers all over the state. Thirty-four replies, more or less complete, were received, and from these the following information was gleaned.

Acres In Bearing. These thirty-four growers have 1682 acres of bearing trees from three to twenty-five years old.

Soils. The soils used and the number of times each is mentioned are: sandy loams, with or without gravel, nineteen times; clay loam, four times; yellow clay, once; limestone, twice; slate, four times; shale and chert each twice.

High Or Low Land. Only five of these orchards are on low land, the others are on high land for the locality. The highest elevation reported is 1350 feet.

Late Spring Frosts. Every correspondent reported injury by late spring frosts in his locality though three claim it is not serious. In some sections two crops in every five or six years are lost. Sixteen reports state that late frosts do more injury than insects or diseases.

Orchard Heating. Orchard heating is not practiced by any of these growers.

Distance Apart Of Trees. The distance apart of planting varies from 15 to 20 feet each way, 18 x 18 and 20 x 20 being the distances most used.

Cultivation. Most of these growers give good thorough cultivation until in July or early August. Only one reported using the mulch culture system.

Cover Crops. Of these thirty-four growers, fifteen do not grow cover crops of any kind. The others use crimson clover, cowpeas, rye, rape, hairy vetch or turnips for this purpose.

First Fruit Produced. The age of orchards when bearing the first fruit is from two to five years, most of them beginning at three years from planting.

Cost Of Preparing Soil To Plant. This varies on cleared land from $2.00 to $10.00 per acre and averages $4.25 for all replies. There was one report of $10.00, one of $8.00, one of $7.50, four of $2.00, one of $2.50, three of $3.00, and the others from $4.00 to $5.00 per acre. This shows a wide range of cost, but this varies with the type of soil and conformation of the surface, the mountain sections being the most expensive to prepare for planting.

Cost Of Trees Per Acre. This very naturally varies with the size, grade and number of trees per acre and the business acumen of the purchaser. The range in cost as reported is from $5.00 to $20.00 and averages $10.00 per acre.

Cost of Planting Trees Per Acre. This varies from $0.50 to $5.00 according to the type of soil and whether it is level and friable or hilly and stony. There is one report of $5.00 and one of $4.00, but the average of all reports is about $2.50 per acre.

Cost Of Cultivation Per Acre, Per Year. This also varies with soil conditions and the amount of cultivation given. The average cost is $4.25, but the range of expense is from $1.50 to $12.00. There is one report of $12.00, one of $10.00, one of $8.00, one of $7.00, one of $6.00, and the others are of $5.00 or less.

Cost Of Annual Pruning Per Acre. This depends on the age of the trees, number per acre and amount of pruning done. The average cost is $1.60, and the variation from $0.50 to $5.00 per acre.

Cost of Thinning Fruit Per Acre. Only eleven of these peach growers do any thinning of the fruit. Five of them report that the average cost is from $2.00 to $6.00 per acre on trees five to ten years old. The average of these five replies is $4.00 per acre.

Packages. Georgia carriers are used by one-half of these men for their best fruit and either the 4/8 or 5/8 bushel basket for their poorer grades. The 4/8 bushel is used much more than the 5/8 bushel size. The bushel box is still used to some extent.

Cost Of Packages Per Acre. The size of crop and style of package govern this expense. The variation given in thirteen replies is from $7.00 to $40.00 and averages $22.00 per acre.

Cost Of Gathering Fruit Per Acre. The expense of labor and yield per acre make this vary from $2.00 to $30.00 with an average of $9.00 for fourteen reports.

Cost Of Grading And Packing Fruit Per Acre. This runs from $1.00 to $20.00 and averages $6.00 for thirteen reports.

Yield Per Acre. Nothing is more variable than the yield. but as the figures given represent averages of crops they are of some value. The yields from seventeen reports run from 25 to 400 bushels per acre, and average 185. Seven men report average yields between 200 and 400 bushels per acre.

Selling Price. A general average price seems to be from $0.40 to $1.00 per 4/8 or 5/8 bushel basket, and from $0.80 to $2.75 per carrier. Most of the fruit is shipped to commission men and Baltimore receives more of it than do any of the other large eastern cities.

Net Proceeds Per Acre. The variation under this heading is from $50.00 to $400.00, except one report of $5.00 and one of *nothing* per acre. The average of eleven replies is $145.00 per acre. The man who reports $400.00 per acre net pays twice as much as anyone else for grading and packing. nearly twice as much for gathering the fruit, as much as anyone else for planting the trees, more for pruning, more for thinning the fruit, and more than anyone else for cultivating and for packages with one exception. This report is on a twenty acre orchard and indicates that money intelligently spent without stinting in raising and marketing a peach crop, is well invested.

Number Of Crops In Ten Years From Planting. The number of crops obtained within ten years after planting the trees varies with location and climatic conditions from three to seven with one report of two. There are three reports of seven crops, five of six crops, eight of five crops, nine of four crops and an average of five crops from twenty-eight reports.

Cost Of Labor. When skilled laborers can be obtained they are paid from $1.50 to $2.50 per day. Unskilled laborers are paid from $0.75 to $1.25 per day.

Cost Of Spraying. The cost of spraying varies with so many conditions that it will not be included here. This item of expense is in a class by itself.

Manure and Fertilizer. Twenty-four reports mention the use of manure or fertilizer, but only twelve state the cost of same per acre which is from $3.00 to $14.00 and averages $8.00.

There are only six reports which give both the cost of fertilizer and the net proceeds per acre, the average cost of fertilizer per acre being $10.00 and the average net returns $161.00.

Varieties. Thirty-eight varieties were listed in the reports. The number of times each of the leading ones was mentioned is as follows: Elberta 29, Smock 14, Crawford Late 12, Salway 10, Champion 10. Chairs 10, Fox 8, Old Mixon 7, Belle 7, Crawford Early 6, Reeves 6. Heath Cling 6, Bilyeu 6, Mountain Rose 5, Stevens 4, and Wonderful 3 times. The other varieties were mentioned only once or twice.

Summary. Using the averages of expense under the headings just discussed, the average cost per acre of a peach orchard the first year is $21.00, divided as follows: $4.25 for preparing the land, $10.00 for the trees, $2.50 for planting and $4.25 for cultivation.

The cost of spraying, of manure and fertilizer, and of cover crops. is disregarded in this summary and must be worked out by each individual grower.

During the second year the average expense is $4.25 for cultivation and $1.60 for pruning.

The third year's expense would be about like the second year unless there is a crop and this ought to pay all expenses incident to picking, grading, packing, packages, etc.

For the fourth and succeeding years without crops the expense per acre should be the same under these averages as the second year The average expense of crop years as it is reported is $48.85, divided as follows: cultivation $4.25, pruning $1.60, thinning $4.00, gathering fruit $9.00, grading and packing $6.00 and packages $22.00.

Since the average number of crops is five in an orchard planted ten years, and since the average expense of each crop is $48.85 (exclusive of fertilizers, spraying and cover crops), the total cost of the orchard for the five crop years is $244.25. Add to this $21.00 as the first year's expense, and $5.85 for the second year and each of the three non-bearing years, and the total expense per acre is $288.65 for a period of ten years. At the average of $145.00 net per acre for each crop year, the total net proceeds per acre for five crops in ten years are $725.00. Deducting the total estimated expense of $288.65 per acre for the ten year period, there is left a profit of $436.35, or an annual profit of $43.63 per acre for ten years after the orchard is planted. The expense of thinning the fruit is included in this juggling of figures, and since most peach men do not thin the fruit this item may stand to offset the expense of spraying. The growers who produce low priced crops usually do not use fertilizers or cover crops so their operations will not change the general average figures. The growers who use fertilizers and good orchard methods receive so much more than $43.63 net per acre that the expense of fertilizers and cover crops will not reduce this general average.

Everything considered, it is quite likely that this estimated average of $43.63 net per acre annually for the first ten years after the peach orchard is planted, is not far from being correct.

PEACH DISEASES*

The principal diseases of the peach in this section are: Brown rot, scab, leaf curl and yellows. Others are crown gall, shot-hole, powdery mildew, frosty mildew. Rosette, a disease similar to yellows, is destructive in parts of the southern states and blight and die back are troublesome in the West. Little peach may extend to Maryland from the north.

Brown rot is caused by the fungus *Sclerotinia fructigena* attacking and rapidly killing the ripe or nearly ripe fruit. It also causes a blight of the flowers and twigs. It is spread by the gray dusty coating of spores on the rotten fruits, even when dried and hanging on the tree over winter, or from another form of spore produced in the spring on the partially buried mummy peaches. It is worse in wet seasons and often causes great loss after the fruit is picked. The fungus usually enters through breaks in the skin due to insects or injury in handling.

Scab. The fungus *Cladosporium carpophilum* causes the familiar roundish, black spots on the fruit. If abundant they may coalesce and cover one side of the peach causing it to shrivel and crack. It is especially bad on late varieties and in wet seasons.

Spraying four or five weeks after the petals fall and again four or five weeks before the fruit ripens, with self-boiled lime-sulfur is the best treatment for brown rot, scab and the minor diseases of leaf and fruit, such as mildew. Late varieties will need another spraying midway between these two, while the earliest require only the first application.

This spray is made by mixing 8 pounds of sulfur with 8 pounds of lime while the latter is slaking, keeping it thoroughly stirred until boiling stops, then adding water at once and straining through a 20 mesh strainer into the spray barrel, diluting to 50 gallons, and applying with a nozzel of medium opening and with thorough agitation.

This is the only safe fungicide to use on peach as the foliage is quite sensitive to chemical injury.

Leaf curl is caused by *Exoascus deformans*, a fungus which begins to grow in the leaves as they develop in spring. These leaves are variously curled, twisted and distorted, and fall in a few weeks, as also does the fruit if the attack is severe. Elberta and some other varieties are especially subject to it.

Spraying during the dormant season with any of the lime-sulfur sprays effective for San Jose scale, is sufficient treatment.

Yellows is a functional disease indicated by premature ripening of the fruit which shows characteristic red spots on the surface and red streaks in the flesh, also poor quality. The leaf buds develop prematurely producing sickly twigs, often in bunches, with narrow yellowish leaves. Nursery stock is easily infected by taking buds from diseased trees. Yellows occurs in all parts of Maryland except Calvert, Charles, St. Mary's, Dorchester, Wicomico, Worcester and Somerset counties.

---

*By J. B. S. Norton.

In *little peach* the fruit remains not over half the usual diameter, ripens later, and the leaves are small and unhealthy.

Trees with either yellows or little peach are worthless and soon die and should be cut and burned, root and branch, as soon as found, to prevent infection of others in the orchard.

These diseases should not be confused with trees stunted or yellow from poor soil, borers, etc.

Crown gall is a rough, tumor-like outgrowth near the surface of the ground on root or stem, and is due to the action of a species of bacteria. The disease is quite injurious and affected nursery stock should not be planted.

PEACH INSECTS.*

The following are the principal insect enemies of the peach in this state, with a brief discussion of the best remedies for their control.

THE BLACK PEACH APHIS.

(*Aphis Persicae niger Smith.*)

This shining black aphis is quite a pest on young peach trees throughout the State. The principal injury is caused by the insect feeding on the roots of nursery trees or orchards just planted, or in the second year. After feeding on the tiny rootlets, in early spring some of the lice will crawl to the new shoots and begin feeding and multiplying there. It thus occurs on both roots and foliage and is similar in habits to the woolly aphis.

This louse is usually attended by ants, so when the latter are observed on or around the tree, it is well to look for this aphis.

REMEDY:

When present on the roots of peach trees, liberal treatment with strong tobacco dust should be given. The soil should be removed from around the trunk of the tree to a depth of about a foot. About a pound of the tobacco dust should be scattered around the roots and the ground filled in on top of it. The trees should be well fed to stimulate vigorous growth.

When the pest is present on twigs and foliage, the trees should be sprayed with Black Leaf, a tobacco extract, diluted at the rate of one part of the solution to forty parts of water.

The fumigation of trees from the nursery should kill any aphis that may be present. Nevertheless, the grower should examine the roots of all trees for this pest before planting.

THE PEACH TREE BORER.

(*Sanninoidea exitiosa Say.*)

This is undoubtedly the most troublesome insect pest of the peach tree in Maryland. The injury is occasioned by the larvae of the moth boring in and around the base of the tree, between the bark and sap wood and just at the surface of the ground. The presence of the borer or worm can be detected by the brownish, gummy exudations, more or less soiled with earth and the larval excrement about the base of the trees. At full growth the larvae are about an inch and a half long, white, with a dark head. The insect winters as a larva in the tree and reaches maturity about the last of June or first part of July, depending on locality. Recent studies of this insect show that some late hatching larvae may go over to the second summer, before transforming into the adult moth.

---

*By T. B. Symons.

REMEDY:

The only practical remedy thus far found, is so called worming trees for the pest. Many experiments have been conducted, employing different insecticides on the trunk of the peach tree, to either deter the moth from depositing her eggs or the larvae from entering the tree, but as yet there is no treatment that has proven satisfactory.

We have found that the best time for worming is about the first to the middle of July. The earth should be taken away from around the trunk of the trees and a close search made for the worms.

The San Jose Scale.

(*Aspidiotus perniciosus Com.*)

This well known pest attacks the peach throughout the State. It may be said that the peach tree is one of its favorite food plants. Descriptions of the insect have been given from time to time. A tree badly infested appears as if coated with ashes. The insect can always be detected by scraping the bark with a knife which will remove the small round scale and if done during summer will reveal the tiny, oval, orange-colored objects beneath. The insect reproduces rapidly, there being about four generations from June to October. The insects remain dormant under the scale during winter.

REMEDY:

The generally recognized remedy for this pest is the Lime Sulphur Wash applied during the time when the trees are dormant. The concentrated solution, which can be bought or made by the grower is now generally used. A standard manufactured lime sulphur solution should be diluted at the rate of one part of the solution to nine parts of water. Full directions for making the concentrated solution will be given in a forthcoming bulletin from this Station.

The Terrapin Scale.

(*Lecanium nigrofasciatum Perg.*)

During the past two years this scale insect has developed to be quite a pest of the peach tree in some parts of the state.

The insect hibernates as a partly mature female. At the approach of spring it becomes active and feeds on the juices of the tree. The females reach maturity about the last of May in this locality, when eggs are deposited under the scale. The eggs hatch in a few days, the tiny young crawling to leaves and settling usually on the underside. In about three weeks they return to the twigs and settle, generally on the underside. The insect secretes honey dew on which a black fungus develops, which spreads on the fruit and causes the principal injury by the pest.

The Terrapin Scale is one of our soft or naked scales, hemispherical in form and about 2½ m. m. in length and slightly less in width. The scale covering is mottled brown with radiating streaks of black toward the sides and an orange red patch on the top.

REMEDY:

The scale can only be controlled by spraying infested trees during the dormant season with a standard, miscible oil at the rate of one part of the solution to fifteen parts of water. While such treatment is liable to injure buds, there is no other solution now known that will control this scale.

During the past year natural parasites have apparently practically eradicated the insect from several orchards in the state.

THE FRUIT BARK BEETLE.

(*Scolytus rugulosus Ratz.*)

This black beetle about ⅛ of an inch in length often causes severe injury to peach trees, by boring into the bark of trunk and limbs. Its presence can be detected by the appearance of small, round holes here and there over the bark. It usually attacks sickly trees, or parts of a tree that may be dead. In neglected orchards the insect is usually found attacking and killing branches or whole trees which have been devitalized by lack of attention. Sometimes trees weakened by overbearing, drought or other cause will be attacked. In such cases the boring causes the tree to bleed excessively, and oftentimes results ultimately in the death of the affected parts. The insect is thus a dangerous one to get a foothold in any orchard.

REMEDY:

There is nothing to do in the case of infestation by this pest but destroy the affected tree or parts by burning. Seldom can a severely attacked tree be saved and it is always best to destroy the insect by burning attacked parts to prevent further trouble.

PLUM CURCULIO.

(*Conotrachelus nenuphar Hbst.*)

This insect is the most important pest affecting the fruit of peach trees. It is the common curculio that attacks plum, peach, and apple. The hump-backed snout-beetle, dark grey in color and about ¼ of an inch in length, winters in the adult state, appearing in spring just as the leaves on peach trees are putting out. At first they feed more or less on the young foliage and fruit, and later the female punctures the latter for the purpose of depositing her eggs. It thus injures the fruit by the punctures, producing a scar, and later the larvae that hatches from the egg bores into it and feeds around the stone, causing it to drop sooner or later.

These punctures also serve as openings for entrance of various disease germs.

REMEDY:

The most practical remedy for this pest is spraying the trees about ten days after the shucks drop, with arsenate of lead, using about two pounds to fifty gallons of water. It is best to add about three pounds of lime to the mixture, to prevent burning of foliage. In cases of bad infestation, the arsenical should be added to the fungicide, which should be applied about three weeks later.

There are several other insects that sometimes attack the peach tree or fruit, but they are not injurious enough to be included in this brief discussion.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 160. OCTOBER, 1911.

STRAWBERRIES.

By C. P. Close, W. R. Ballard and T. H. White.

INTRODUCTION.

In December, 1907, Bulletin No. 124 on Strawberries was published by the Experiment Station. Since then we have continued to add to our testing beds from 30 to 40 new varieties each year and have fruited annually about 150 varieties. Among the new varieties are some very good ones as well as some rather poor ones for our conditions, and the special purpose of this bulletin is to bring to the attention of our fruit growers the descriptions of the new varieties we have fruited during the past four seasons and also of some of the older ones not described in bulletin No. 124. A large portion of the cultural directions in this bulletin are copied from bulletin No. 124 since this latter bulletin is practically out of print.

Soil and Climatic Conditions.

The soil here at the Experiment Station is not regarded as especially good for strawberries being a rather heavy, cold, clay loam, uneven in texture and quality.

The seasons of 1908, 1909, 1910 and 1911 have not been extremely favorable for strawberry culture because of heavy rains at picking time, except in 1911, and of long dry summers, except in 1908. The dry seasons reduced the stand of plants and this must be considered in comparing the yields. The spring of 1911 seemed to be more unpromising than any of the others because of long-continued cold, dry weather, followed immediately by hot and dry conditions. The plants did remarkably well, nevertheless, and the early varieties ripened up a good crop. After the third picking a good rain came, and the midseason and late varieties also produced well.

Although there were low winter temperatures there was little if any winter killing of the fruit buds or plants.

Recommending Varieties.

The various varieties are so particular in their local requirements of soil and climatic conditions that we are cautious in recommending varieties for any locality. The only way to know if a variety will succeed in a certain place is to try it and find out. We urge every strawberry grower to have a testing bed of his own and try all promising new varieties.

There are several good new kinds which ought to be tested over the entire state as follows:— Big Victor, Chesapeake, Chipman, Clara, Early Ozark, Fendall, First Prize, First Quality, Goldsborough, Goree, Heritage, Howard 17, Longworth, Manhattan, Matthew Crawford, Maryland, Meteor, Orem, Outlander and Wooster.

SELECTING, PREPARING AND IMPROVING THE SOIL.

A sandy loam is best for the strawberry, but heavier loams may be used if necessary. Freshly plowed sod should be avoided because of the various insects, especially cut worms, white grubs and wire worms, which it contains. It is well, also, to avoid corn and melon fields which have been infested with aphids, because the ants which associate with corn and melon aphids will also associate with strawberry aphids. Thus it is that if the ground is already infested with ants when strawberries are planted the strawberry aphis will spread quickly if it is introduced in any way. Sweet potatoes, round potatoes and tomatoes are good crops to precede strawberries, because they require thorough cultivation.

If tomatoes are being grown, crimson clover seed, 20 pounds per acre, should be sown at the last cultivation, so as to have a good cover crop to plow under in the spring. Irish potatoes should be immediately followed by crimson clover seed. It may be too late to sow crimson clover seed after sweet potatoes are dug, and in that case rye, one bushel per acre, should be used. The object is to get as much green vegetable matter as possible to plow under.

If it is desired to improve very poor land for strawberry growing sow cowpeas, one bushel per acre in May, plow them under early in August and sow crimson clover seed, 20 pounds per acre; plow this under in the spring and set the strawberries. If some special crop occupies the ground during the summer sow the crimson clover seed as early in August as possible, plow down the crop in May following, sow cowpeas, turn these under perhaps in September, and sow rye, plow this down in spring and set the strawberry plants. If stable manure can be procured it may be used most liberally even up to 40 tons per acre before planting tomatoes, round or sweet potatoes, and after these crops are gathered more manure or cover crops may be used before strawberries are planted. By following either of these plans large amounts of vegetable matter will be added to the soil and that is just what strawberries delight in and need. New ground is best for strawberries because it is full of vegetable matter, but since new ground is not always available it becomes necessary to make old ground resemble it in physical condition and fertility. The soil should be thoroughly worked into a loose and friable condition for receiving the plants in spring.

FERTILIZERS.

The question of fertilizers for strawberries can be discussed only in a general way, because so many factors enter in, such as different grades of soil, different degrees of fertility of the soil, different previous treatment and crops, and different seasonal conditions and handling of the fruiting bed.

The 3-9-7 formula (3 per cent. nitrogen, 9 per cent. potash and 7 per cent. phosphoric acid) seems to be a popular one for strawberries, and the amounts of fertilizer in the first formula below are suggested per acre as furnishing enough plant food to comply with this formula. If the grower wishes to use more than these amounts it might be well to increase all in the same proportion:

Per acre	100 lbs. nitrate of soda, or 75 lbs. sulphate of ammonia, or 250 lbs. cottonseed meal. 90 lbs. sulphate of potash, or 95 lbs. muriate or potash, or 400 lbs. kainit. 250 lbs. acid phosphate, or 250 lbs. dissolved bone.

A little variation from the above is:

500 to 1000 lbs. Per acre	500 to 700 lbs. ground fish, bone meal or tankage. 200 lbs. muriate of potash. 1,100 to 1,300 lbs. acid phosphate.

Other amounts sometimes used are:

Per acre new bed	200 lbs. muriate of potash. 600 lbs. dissolved S. C. Rock.
Per acre old beds	100 lbs. nitrate of soda. 200 lbs. muriate of potash. 200 lbs. dissolved S. C. Rock.

For new beds the fertilizer should be applied in spring, before the plants are set, either broadcast by wheat drill, or otherwise, or along the rows. In either case, but especially in the latter, the fertilizer must be thoroughly mixed into the soil with the cultivator or it may injure or destroy many of the plants.

If beds are to be kept for second year fruiting the fertilizer should be applied along the rows when they are cleaned up after the first crop is picked.

Nitrate of soda is sometimes used on fruiting beds about blossoming time being applied along the rows at the rate of 75 to 100 pounds per acre.

SEX IN STRAWBERRIES.

The fact that some varieties have imperfect, pistillate or female blossoms, and others have perfect blossoms which are called staminate, bi-sexual, or male blossoms, and that varieties with imperfect blossoms should be planted next to those with perfect blossoms in order to obtain proper pollination of all blossoms and a good setting of fruit, is well understood. From two to four rows of any imperfect flowered variety should be alternated with from one to four or more rows of a perfect flowered variety blooming at the same time. It is even claimed that perfect flowered varieties will fruit better if planted in alternate sets of rows so as to secure cross pollination.

SETTING THE PLANTS.

Set the plants as early in the spring as possible. In Southern Maryland and the southern part of the Eastern Shore, the ground is sometimes prepared in late fall and the planting is done in winter whenever the weather permits. The plants are trimmed for setting by taking off all dead leaves and all except one or two of the live ones, and cutting the roots back to about three inches in length. This root pruning is quickest done with pruning shears or knife removing all of the surplus roots from a bundle of 25 plants at one or two cuts. Keep the plants moist; a bucket containing a little water is handy for this purpose while planting. A spade or broadbladed dibble is convenient for opening up the soil to receive the plant. The particular point is to place the plants so the crown is just above ground and to press the soil firmly around the roots. The opening made to receive the plant must be entirely closed.

The matted row system is best adapted for commercial purposes. The rows are usually made three and one-half or four feet apart and the plants are set from 15 to 18 inches apart in the row. The width of the matted row depends upon the wishes of the grower, he may have it either wide or narrow. If blossoms appear they should be removed so the plants will put all of their energy into growth.

CULTIVATION.

The ground must be thoroughly cultivated during the entire growing season to keep it loose and friable. This condition of the soil is beneficial in several ways. It allows the air to penetrate the soil which is necessary as roots need air; it retains moisture in the soil by preventing rapid evaporation from the surface; it assists in breaking down plant food which would otherwise remain insoluble and it keeps the ground free from weeds which rob the plants of moisture.

It is not a usual practice to cultivate the fruiting beds in spring, but this ought to be done to loosen up the soil so it will hold more moisture and evaporate less, and thus in case of drought the crop will not suffer so quickly if at all.

MULCHING.

As soon as the ground freezes the plants should be covered with straw, coarse manure, pine needles, sea weed, or something else to prevent frost from heaving out the plants. If the new growth in spring cannot easily work its way up through the mulch it is necessary to remove enough of it so as not to injure the plants. The mulch must be left beneath the plants so as to keep the berries from touching the earth and also to prevent the rain from spattering them with sand and dirt. In fact, even if the winter is not severe enough to require mulching for protection, it should be done anyway to protect the berries from dirt and sand for gritty fruit is a drug on the market.

PICKING AND PACKING THE FRUIT.

Too much emphasis cannot be laid on the care necessary in picking and packing strawberries. The fruit stem should be pinched off carefully without bruising or even pressing on the berry with the hand. Only good fruit should be picked for shipment. The baskets should be well filled so as not to appear slack when they are offered for sale in the market. The 24 and 32 quart crates are by far the best to use as these sizes handle better, carry better, and sell better than larger crates. Above all things use only clean, new crates and baskets, because soiled ones are almost a disgrace to modern berry growing. Aside from the aesthetic feature and the satisfaction of putting good fruit in clean packages, it pays financially to invest in bright new baskets and carriers.

RENEWING OLD BEDS.

As soon as the fruit is gathered it is well to mow the patch and burn it over quickly as soon as dry enough, so as to destroy as much of foul matter, fungous diseases and insects as possible. Then plow between the rows throwing furrows together and cut the rows to about one foot in width. Thin out the remaining plants leaving only the young, vigorous ones, and cultivate the ground level between the rows. Another way is to plow down one-half of the width of each row, cultivate well and let new runners cover it from the remaining half. When enough new plants are established the old portion of the row should be plowed down and cultivated and practically a new plantation will be secured. Cultivation should be continued until the end of the growing season. Ordinarily the strawberry field is plowed up and planted to some other crop after the second year, principally because of the expense of cleaning up an old bed.

If it is desired to grow one's own plants this may be done by planting a few rows extra for this special purpose. The practice is a good one.

Our attention was recently called to a patch of the Gandy which was fruited for the sixth time in 1911. This patch is on a northern slope, and is heavily mulched with wheat straw every year at the beginning of winter. This heavy mulch retards the growth of the plants in the spring and also retards the ripening of the fruit until all other Gandy patches in the neighborhood are picked. Prices are high then and the proceeds of this patch are most satisfactory. When picking ceases, an old style double shovel corn cultivator is run through the matted rows to tear out strips of plants. If necessary, the remaining plants are thinned out also. Not much cultivating is necessary on account of the accumulated mulch of several years. With such care a strawberry bed can be continued for many years.

MULCHING EXPERIMENTS 1908 TO 1911.

The experiments in mulching strawberries carried on between 1902 to 1907 and recorded in Bulletin No. 124, indicated that considerable value was derived from mulching. Since that time the work has been continued using straw as a winter mulch and this has been supplemented by spring cultivation.

The following plans have been followed since that time, the variety being Tennessee.

Plot 1. Not mulched, but cultivated in the spring.
Plot 2. Mulched in early winter, but cultivated in the spring.
Plot 3. Mulched in early winter, but not cultivated in the spring.
Plot 4. Check, not mulched nor cultivated in the spring.

All plots were cared for alike through the summer and the mulching material was put on both plots at the same time in the early winter. The spring cultivation was done two or three times, depending upon the condition of the land, between the opening of spring and the blooming period.

The following are the yield in quarts per acre for the four years, 1908 to 1911.

Table Showing the Yield in Quarts per Acre for Four Years of Mulched, Unmulched, and Check Plots, the Total Yield and the Average Yield for Each Plot.

Plot.	Mulched.	Cultivated in spring.	1908 Quarts per acre.	1909 Quarts per acre.	1910 Quarts per acre.	1911 Quarts per acre.	Total yield of 4 years. Quarts.	Average yield of 4 years. Quarts.
1	No	Yes	3700	4028	4849	1872	14449	3612
2	Yes	Yes	4200	4598	5053	2556	16407	4101
3	Yes	No	6400	4332	4495	1764	16991	4275
4	No	No	4300	4598	5053	1352	15203	3800

The above figures again illustrate the value of mulching. Plot 3 which is mulched and not cultivated having an average of 475 quarts per acre more than the check. There is another consideration, however, that the figures do not show, and that is, that the berries from the mulched plots were always brighter, cleaner and often larger than the unmulched.

With regard to the spring cultivation it does not appear that this was of any value, except in the season of 1911 when the month of May was very dry, and there was a gain of 520 quarts per acre in favor of spring cultivation. Taking the average for the four seasons, however, there is a loss by spring cultivation of 188 quarts per acre.

It was observed during the growing season that the plants on the spring cultivated plots usually grew more luxuriantly and did not ripen fruit quite as early as the uncultivated plots. In this section, owing to the hot weather coming early in June when the plants cease to bear, the earlier the start the better will be the yield.

Table of Varieties, Sex, Blossoming Period, Season and Yield Per Acre.

The following table gives a complete list of all of the newer varieties which were tested here during 1908, 1909, 1910 and 1911. The varieties are arranged alphabetically, being followed by "S" (staminate or perfect bloom) or "P" (pistillate or imperfect bloom), the per cent. of a full stand of plants, the date of blossoming, the season of ripening, and the yield per acre.

VARIETIES, SEX	1908				1909				1910				1911			
	Percentage of stand	Blooming Period	Season of ripening	Yield qts. per A.	Percentage of stand	Blooming period	Season of ripening	Yield qts. per A.	Percentage of stand	Blooming period	Season of ripening	Yield qts. per A.	Percentage of stand	Blooming period	Season of ripening	Yield qts. per A.
Alfonso XVIII, S.	....	....	....	....	....	....	....	....	75	April 9-May 7	May 14-June 7	1998	40	May 5-16	June 1-8	432
Annie, S.	....	....	....	....	40	April 26-May 15	May 24-June 12	1815	100	April 4-May 7	May 14-June 4	3294	75	May 5-16	May 27-June 8	1458
Autumn, P.	....	....	....	....	....	....	....	....	10	April 14-May 7	May 25-June 4	2106	10	May 8-18	....	....
Barrymore, S.	....	....	....	....	....	....	....	....	40	April 13-May 7	May 18-June 11	2214	100	May 8-20	June 1-10	2268
Battenberg, S.	....	....	....	....	....	....	....	....	75	April 16-May 10	May 25-June 11	4482	100	May 8-18	May 27-June 10	2106
Better Belt, S.	....	....	....	....	....	....	....	....	40	April 6-May 7	May 21-June 7	945	40	May 6-16	June 1-5	189
Biedler, P.	....	....	....	....	....	....	....	....	75	April 13-May 9	May 21-June 7	3780	40	May 8-18	June 1-8	918
Big Victor, S.	....	....	....	....	....	....	....	....	100	April 9-May 10	May 25-June 11	3996	100	May 5-18	June 1-14	1890
Black Beauty, S.	....	....	....	....	....	....	....	....	....	....	....	....	100	May 6-18	May 27-June 10	2754
Blaine, S.	....	....	....	....	....	....	....	....	75	April 18-May 12	May 25-June 11	2322	100	May 13-21	June 3-10	1242
Bradley, S.	....	....	....	....	75	April 26-May 15	May 28-June 14	2577	75	April 6-May 7	May 21-June 11	5940	100	May 3-18	June 1-10	2808
Charles Newman, S.	....	....	....	....	75	April 26-May 15	May 20-June 10	3993	100	April 5-May 7	May 14-June 4	3672	100	May 5-16	May 27-June 8	1404
Chesapeake, S.	100	April 29-May 16	May 28-June 12	2722	75	May 4-18	June 1-14	2831	10	April 25-May 10	May 27-June 11	486	75	May 12-20	June 1-8	756
Chipman, S.	....	....	....	....	75	April 24-May 17	May 24-June 14	1761	100	April 11-May 7	May 18-30	3348	40	May 3-18	May 27-June 8	324
Clara, S.	....	....	....	....	....	....	....	....	....	....	....	....	100	May 8-18	June 1-14	2214
Clark Seedling, S.	....	....	....	....	....	....	....	....	40	April 6-May 7	May 21-June 11	2160	75	May 5-18	June 1-8	1998
Colossus, P.	....	....	....	....	75	May 1-15	May 28-June 14	3262	75	April 14-May 7	May 18-June 7	5427	10	May 8-18	June 1-8	594
Columbia, P.	....	....	....	....	....	....	....	....	....	....	....	....	75	May 13-22	June 1-14	2106
Cooper, S.	....	....	....	....	....	....	....	....	100	April 11-May 7	May 21-June 4	1998	75	May 8-18	June 1-5	594
Corsican, P.	....	....	....	....	....	....	....	....	40	April 16-May 7	May 21-June 11	2376	75	May 6-18	May 27-June 10	1954

Dicky, S.	....	....	....	....	75	May 1-15	May 28- June 14	1887	100	April 16- May 7	May 21- June 11	3465	75	May 8-20	May 27- June 8	1890
Dighton Rock, S.	....	....	....	....	75	April 28- May 15	June 1-14	1524	75	April 13- May 7	May 25- June 11	2916	10	May 6-18	May 27- June 8	270
Dixon, S.	....	....	....	....	....	....	....	....	40	April 5- May 7	....	....	75	May 5-18	May 27- June 10	702
Dornan, S.	....	....	....	....	....	....	....	....	100	April 14- May 7	May 21- June 7	4482	75	May 5-18	June 1-10	1350
Downing Bride, S.	....	....	....	....	....	....	....	....	40	April 11- May 7	May 25- June 7	972	75	May 6-16	May 27- June 10	756
Earliest of All, S	....	....	....	....	....	....	....	....	100	April 11- May 7	May 21- June 7	4294	100	May 6-16	May 27- June 8	972
Early Harvest, P.	....	....	....	....	75	April 26- May 14	May 24- June 12	3502	100	April 9- May 7	May 14- June 1	2565	75	May 3-15	May 27- June 8	540
Early Miller, S.	....	....	....	....	....	....	....	....	....	....	....	....	100	May 4-15	May 23- June 5	1674
Early Ozark, S.	....	....	....	....	....	....	....	....	100	April 4- May 7	May 14- June 7	5.70	75	May 3-15	May 27- June 8	1566
Empress, S.	....	....	....	....	....	....	....	....	....	....	....	....	100	May 6-18	May 27- June 8	2052
Enhance, S.	....	....	....	....	....	....	....	....	100	April 11- May 7	May 21- June 11	6318	100	May 6-18	June 1-8	4266
Evening Star, S.	....	....	....	....	....	....	....	....	40	April 23- May 7	May 27- June 16	1620	100	May 6-18	May 27- June 14	3240
Fendall, P.	....	....	....	....	100	April 30- May 17	June 1-21	7078	100	April 9- May 7	May 21- June 11	5292	75	May 8-20	June 1-14	1728
First Prize, S.	....	....	....	....	....	....	....	....	....	....	....	....	100	May 6-18	May 27- June 10	3618
First Quality, S.	....	....	....	....	....	....	....	....	....	....	....	....	100	May 6-19	May 27- June 14	4536
Florella S.	....	....	....	....	....	....	....	....	10	April 11- May 7	May 18- June 1	1215	75	May 5-16	May 27- June 8	1954
Fremont Williams, S.	....	....	....	....	40	May 8-17	June 1-14	1125	....	....	....	....	....	....	....	
Gandy, S.	75	April 30- May 17	June 1-9	835	....	....	....	..	10	April 20- May 7	May 30- June 7	594	75	May 9-20	June 3-10	1188
Garrison, S.	....	....	....	....	....	....	....	....	....	....	....	....	75	May 8-20	June 1-10	810
Gem, S.	....	....	....	....	....	....	....	....	40	April 11- May 7	May 25- June 7	1080	75	May 6-18	June 1-14	1080
Gill, S.	....	....	....	....	75	April 26- May 15	May 28- June 10	3339	100	April 4- May 7	May 14- June 1	7344	75	May 4-16	May 23- June 5	1296
Gold Dollar, S.	....	....	....	....	....	....	....	....	40	April 9- May 7	May 18- June 1	1809	100	May 5-18	June 1-8	1296
Golden Gate, S.	....	....	....	....	75	May 1-15	June 1-17	1778	40	April 12- May 7	May 25- June 11	3726	10	May 8-18	June 1-8	648
Goldsborough, S.	100	April 28- May 16	May 26- June 9	4646	75	April 30- May 15	June 5-19	1815	40	April 11- May 7	May 21- June 7	2484	75	May 5-20	June 1-8	972
Good Luck, S.	75	May 4-14	June 1-12	3339	100	May 6-17	May 28- June 19	2468	40	April 20- May 9	May 25- June 11	2214	40	May 10-20	June 3-8	756

VARIETIES, SEX	1908				1909				1910				1911			
	Percentage of Stand	Blooming Period	Season of Ripening	Yield qts. per A.	Percentage of Stand	Blooming Period	Season of Ripening	Yield qts. per A.	Percentage of Stand	Blooming Period	Season of Ripening	Yield qts. per A.	Percentage of Stand	Blooming Period	Season of Ripening	Yield qts. per A.
Goree, S.	...	...	...	...	...	...	...	...	...	...	...	...	100	May5-18	May 27-June 8	1954
Governor Rollins, S.	...	...	...	...	75	April 26-May 15	May 28-June 14	1759	40	April 11-May 7	May 21-June 11	2700	100	May 5-18	June 1-10	1890
Great Ruby, S.	...	...	...	...	...	...	...	...	...	...	...	...	75	May 5-16	May 27-June 10	1782
Great Scott, P	...	...	...	...	40	April 28-May 17	May 28-June 12	907	40	April 14-May 9	May 25-June 7	1188	40	May 6-16	June 1-10	432
Greenville, P.	...	...	...	...	...	...	...	...	40	April 14-May 7	May 21-June 11	2160	40	May 6-18	June 1-5	378
Haverland, P.	100	April 25-May 11	May 26-June 12	2178	75	April 28-May 15	May 28-June 14	2577	100	April 5-May 10	May 21-June 11	8370	75	May 6-19	June 1-8	1674
Helen Gould, P.	...	...	...	...	75	April 28-May 15	June 1-14	1524	40	April 13-May 7	May 21-June 7	2619	10	May 8-18	June 1-5	108
Heritage, S.	...	...	...	...	...	...	...	...	75	April 11-May 7	May 21-June 11	5400	100	May 6-18	June 1-14	1728
Highland, P.	...	...	...	...	...	...	...	...	75	April 11-May 7	May 18-June 11	5994	40	May 5-18	June 1-8	810
Holland Seedling, S.	...	...	...	...	40	April 28-May 15	May 28-June 14	1524	100	April 11-May 7	May 21-June 7	4131	100	May 5-18	June 1-8	1954
Howard 17, S.	...	...	...	...	...	...	...	...	40	April 6-May 7	May 14-June 7	3996	75	May 5-20	May 27-June 10	2700
Hustler, P.	...	...	...	...	...	...	...	...	40	April 11-May 7	May 14-June 11	3055	10	May 8-20	...	54
Ionian Market, P.	...	...	...	...	...	...	...	...	10	April 11-May 7	May 18-June 1	1107	75	May 5-18	June 1-8	1453
Island King, S.	...	...	...	...	...	...	...	...	...	...	...	...	100	May 6-18	May 27-June 8	2052
Jim Dumas, S.	...	...	...	...	75	April 26-May 18	May 28-June 12	5009	75	April 5-May 7	May 14-June 7	5994	75	May 4-16	May 27-June 3	540
July, P.	...	...	...	...	75	May 4-18	June 1-19	4460	100	April 18-May 14	May 25-June 11	3294	75	May 9-20	June 1-10	1566
Keavitt Wonder, S.	...	...	...	...	...	...	...	...	...	...	...	...	75	May 6-18	May 27-June 8	1134
King Edward, S.	...	...	...	...	...	...	...	...	...	...	...	...	100	May 6-18	June 1-10	3204
Lady Finger, S.	...	...	...	...	...	...	...	...	75	April 6-May 7	May 18-June 7	1836	100	May 3-18	June 1-8	1404
Lady Townsend, S.	...	...	...	...	...	...	...	...	...	...	...	...	75	May 4-18	May 23-June 8	2205
Laxton Commander, S.	100	April 29-May 16	June 1-9	1524	10	May 1-17	June 5-14	870	40	April 14-May 7	May 21-June 11	1566	10	May 9-18	June 3-8	297

Lea, S.													100	May 3-16	May 27-June 8	1954
Lester Lovett, S.			June 1-9	1089			June 1-19	2178								
Little Jap, S.			May 28-June 9	726	10	May 1-14	June 5 14	435	40	April 5-May 7	May 25-June 11	810	10	May 5-16		54
Livingston, S.					100	April 26-May 15	May 24-June 10	2777	75	April 4-May 7	May 14-June 4	1836	100	May 3-16	May 27-June 5	1134
Longfellow, S.													100	May 3-18	May 27-June 10	1998
Longworth, P.	100	April 29-May 16	June 1-12	3448	75	May 1-15	June 5-19	3448	75	April 16-May 7	May 25-June 11	3284	75	May 9-18	May 27-June 14	2133
Louis Gaulthier, P.	40	April 27-May 16	May 28-June 6	1016	40	April 30-May 15	June 1-14	1597	75	April 12-May 7	May 21-June 7	3780	75	May 8-18	May 27-June 10	1566
Mammoth Beauty, S.					75	April 26-May 15	May 28-June 14	2105	40	April 6-May 7	May 18-June 7	3024	40	May 5-18	May 27-June 10	1674
Manhattan, S.													100	May 5-16	June 1-10	86
Margaret, S.									100	April 14-May 10	May 21-June 11	3024	75	May 8-18	June 1-8	540
Matthew Crawford, S.									40	April 16-May 7	May 25-June 4	1134	75	May 9-18	June 1-10	1512
Maryland, S.									100	April 6-May 7	May 14-June 7	6817	100	May 5-18	May 27-June 8	2268
Mascot, S.									75	April 4-May 7	May 14-June 4	5346	100	May 3-18	May 23-June 8	1701
Meek Early, S.													100	May 3-15	May 27-June 10	1026
Meteor, P.													100	May 8-20	June 1-14	5346
Michel, S.	75	April 25-May 8	May 28-June 1	1089	75	April 24-May 12	May 20-June 5	2613	100	April 4-May 29	May 14-June 1	2916	100	May 3-15	May 27-June 3	216
Miller, S.									40	April 15-May 7	May 25-June 4	1512	75	May 6-18	June 1-10	1350
Missionary, S.													75	May 4-18	May 27-June 8	1674
Morning Star, S.					75	April 26-May 15	May 28-June 14	1597	75	April 5-May 7	May 18-June 1	1161	75	May 5-16	May 27-June 8	1404
Mrs. Miller, P.					75	April 26-May 15	May 28-June 14	5652	75	April 12-May 7	May 21-June 7	4860	100	May 5-18	June 1-10	2268
Mrs Miller									75	April 14-May 10	May 25-June 11	5562				
Myer, P.									10	April 6-May 7	May 21-June 7	2268	75	May 6-18	June 1-8	1512
Nettie, P.	100	May 4-16	June 9-12	3630	75	May 8-18	June 5-21	3884								
North Shore, S.	75	April 27-May 12	May 26-June 9	1161	75	April 26-May 15	May 20-June 14	1960								
Norwood, S.									100	April 12-May 7	May 21-June 4	2372	75	May 6-18	June 1-8	918
Oregon Ironclad, S.									40	April 11-May 7	May 25-June 4	324	40	May 8-16	June 1-8	405

VARIETIES, SEX	1908				1909				1910				1911			
	Percentage of stand	Blooming period	Season of ripening	Yield qts. per A.	Percentage of stand	Blooming period	Season of ripening	Yield qts. per A.	Percentage of stand	Blooming period	Season of ripening	Yield qts. Per A.	Percentage of stand	Blooming period	Season of ripening	Yield qts. per A.
Orem, S.					75	May 8-18	June 5-21	2395	40	April 20-May 12	May 27-June 11	1890	40	May 13-20	June 5-8	216
Oswego, S.					75	April 28-May 17	May 28-June 14	1089	75	April 11-May 7	May 21-June 7	2754				
Outlander, P.					75	May 6-17	June 5-21	6969	100	April 18-May 10	May 21-June 11	5724	10	May 9-18	June 1-5	108
Parker Earle, S.													75	May 5-16	June 1-14	1620
Parsons, S.	100	May 4-20	June 1-12	6388	100	April 28-May 18	May 28-June 14	4245	75	April 6-May 7	May 18-June 11	5968	75	May 6-18	May 27-June 10	1242
Pennsylvania Dutchman S.					75	April 28-May 15	June 1-12	726	75	April 12-May 7	May 21-June 11	3942	75	May 5-16	June 1-10	972
Paul Jones, P.									75	April 11-May 10	May 18-June 11	4941	10	May 8-20	June 1-8	756
Pennell, S.									40	April 14-May 7	May 18-June 4	1809	75	May 8-20	May 27-June 10	1080
Pinneapple, S.									100	April 16-May 9	May 25-June 7	2322	100	May 9-20	June 1-10	1458
Pocahontas, S.					40	April 30-May 17	May 28-June 14	1125	100	April 12-May 7	May 21-June 4	3105	75	May 6-18	June 1-8	1458
President, S.									75	April 11-May 7	May 21-June 7	2970	75	May 8-18	June 3-8	702
Pride of Michigan, S.					100	April 28-May 15	June 1-12	435	100	April 12-May 7	May 21-June 11	2376	75	May 6-16	May 27-June 10	891
Professor Fischer, S.					10	May 1-15	June 5-14	1706	10	April 11-May 7	May 27-June 7	1026	10	May 9-16	June 5-10	2176
Prolific, S.													100	May 9-18	May 23-June 14	2268
Reba, P.									10	April 14-May 7	May 25-June 7	1566	75	May 13-18	June 1-8	1126
Red Bird, S.					75	April 26-May 15	May 28-June 14	5190	75	April 5-May 7	May 14-June 7	6021	75	May 5-18	May 27-June 8	1205
Ryckman, S.					75	April 28-May 14	June 1-12	653	75	April 9-May 7	May 21-June 4	3051	75	May 6-18	June 1-8	918
Saunders, S.									75	April 18-May 9	May 21-June 11	5724	100	May 10-22	May 27-June 8	3672
St. Louis					100	April 28-May 14	May 20-June 10	3267								
Saratoga S.					40	April 30-May 15	May 28-June 14	2141	75	April 11-May 9	May 18-June 7	4293	40	May 9-18	June 1-8	648

Shipping King, S					75	April 28-May 15	June 1-14	1887	40	April 9-May 7	May 25-June 4	1674	75	May 5-16	May 27-June 8	918
Sunshine, S													100	May 4-18	June 1-8	2862
Swedenborg, S									75	April 4-May 7	May 18-June 1	2626	75	May 4-18	May 27-June 10	1998
Taft, P					40	May 6-17	June 1-14	2830	10	April 14-May 7	May 25-June 7	1134	75	May 9-20	June 1-8	918
Tennessee, S	75	April 25-May 16	May 26-June 9	2432	75	April 26-May 15	May 28-June 14	2214	100	April 9-May 10	May 21-June 7	6588	40	May 6-18	June 1-8	702
Texas, S									40	April 4-May 7	May 14-June 11	2754	75	May 4-16	May 27-June 5	1080
Three Ws, S					75	April 26-May 17	May 24-June 14	5517	75	April 6-May 10	May 21-June 4	5238	10	May 5-16	May 27-June 10	972
Twilley, S													75	May 5-16	May 27-June 10	1188
Velvet, P					75	April 28-May 14	May 24-June 14	2395	75	April 11-May 7	May 18-June 8	3780	75	May 6-18	May 27-June 14	1134
Victor, S					10	April 28-May 14	June 5-12	217	10	April 5-May 7	May 18-June 4	567	40	May 5-15	May 27-June 3	189
Virginia, P	75	April 27-May 14	May 28-June 9	2613	75	April 26-May 17	May 24-June 14	3848	75	April 12-May 7	May 14-June 11	3419	40	May 5-16	May 27-June 8	540
Waldorf, S									40	April 5-May 7	May 14-June 4	1322	75	May 5-17	June 1-5	162
Winchell Beauty, P							May 28-June 17	5735	100	April 9-May 10	May 18-June 11	5778	40	May 4-16	June 1-10	918
Wine, S													75	May 5-18	May 27-June 10	2160
Wonder, S					75	April 28-May 15	June 1-12	544	100	April 11-May 7	May 21-June 7	2808	75	May 6-18	June 1-8	702
Wooster, P									100	April 9-May 7	May 18-June 7	5076	100	May 6-16	May 27-June 10	2673
World Champion, S									10	April 13-May 7	May 25-June 7	540	100	May 9-20	May 27-June 8	1458

TEN BEST YiELDING VARIETIES

QUARTS PER ACRE IN 1908, 1909, 1910 and 1911.

VARIETY	Sex	1908 Qts.	VARIETY	Sex	1909 Qts.	VARIETY	Sex	1910 Qts.	VARIETIES	Sex	1911 Qts.
Buster	P	9474	Fendall	P	7078	Maryland	S	9558	Meteor	P	5346
Parsons	S	6388	Oak Early	S	6969	Haverland	P	8370	First Quality	S	4536
Togo	S	6171	Outlander	P	6969	Howard	P	7830	Enhance	S	4266
Wolverton	S	4900	Howard	S	6860	Gill	S	7344	Saunders	S	3672
Bowman, 24D	P	4795	Cardinal	P	6570	Tennessee	S	6588	First Prize	S	3618
Abington	S	4719	Winchell Beauty	P	5735	Enhance	S	6318	Evening Star	S	3240
Lyon	P	4683	Buster	P	5662	Buster	P	6048	Manhattan	S	3181
Goldsborough	S	4646	Mrs. Miller	P	5652	Red Bird	S	6021	King Edward	S	3024
Gen. Joe Wheeler	S	4465	Three Ws	S	5517	Highland	P	5994	Sunshine	S	2862
Cardinal	P	4428	Jim Dumas	S	5009	Jim Dumas	S	5994	Bradley	S	2808

VARIETIES.

The descriptions cover the main points of interest concerning the plants and fruit of each variety. The letter following the name of each variety designates its sex—"S" means staminate or perfect flowers and "P" means pistillate or imperfect flowers. The individual or firm name enclosed in brackets means that individaul or firm furnished the plants used for testing purposes. In case plants were taken from an old bed and planted in a new one the words "Station plot" are used to indicate it.

Alfonso XVIII, S—(Vaughan's Seed Store). Plants small, not vigorous; leaflets small, dark; flowers perfect; trusses short, erect; berry uniform, roundish, flattened, medium to large in size, light crimson; flesh white, moderately firm; flavor tasteless; quality poor; core white, solid; calyx medium size, diseased, separates easily.

Annie, S—(Louis Hubach). Plants large, vigorous; leaflets large, dark, flowers perfect; trusses large, erect; berry uniform, necked, roundish, some what irregular, medium, bright crimson; flesh pink, firm, juicy mild subacid, nearly sweet, fair; core red, solid; calyx medium, separates easily; seeds many.

Autumn, P—(M. Crawford Co.). Plants small, not vigorous; leaflets small, dark; flowers imperfect; trusses short, drooping; berry uniform, roundish, small, dull crimson, very slightly pitted; flesh light to dark red, firm, juicy, mild subacid, fair; core light red, solid; calyx small, adherent; seeds many, small.

Barrymore, S—(H. L. Crane). Plants large, vigorous, considerable disease; leaflets large, dark; flowers perfect; trusses short, drooping; berry uniform, long conic, flattened, somewhat irregular, medium to very large, light and dark scarlet; flesh light red, firm, juicy, mild subacid, fair; core white, soft; calyx large, persistent, diseased; seeds many, small.

Battenberg, S—(M. Crawford Co.). Plants large, vigorous; leaflets small, dark; flowers perfect; trusses short, drooping; berry not uniform, ridged, roundish wedge shaped, very irregular, large to very large, light and dark scarlet; flesh white to light red, firm, rather dry, mild subacid, flat, fair; core pink, solid; calyx large, persistent.

Better Belt, S—(Vaughan's Seed Store). Plants small, vigorous, considerable disease; leaflets large, dark; flowers perfect; trusses small, drooping; berry uniform, roundish-conic, blunt, sometimes flattened and irregular, moderately large, rich scarlet; flesh red, firm, juicy, mild subacid, nearly sweet, fair; core red; calyx small, persistent.

Biedler, P—(R. M. Kellogg Co.). Plants large, vigorous, diseased; leaflets moderately large, dark; flowers imperfect; trusses large, drooping; berry uniform, wedge shaped, irregular, medium to large, dull scarlet; flesh light red, firm, juicy, subacid, fair; core pink, solid; calyx medium, does not separate easily.

Big Victor, S—(Moore & Simon). Plants large, vigorous; leaflets large, light; flowers perfect; trusses large, drooping; berry not uniform, necked, roundish-conic, flattened, irregular, medium to very large, rich scarlet; flesh light red, firm, rather dry, very mild subacid, good; core pink, soft; calyx very large, separates easily.

Black Beauty, S—(J. E. Kuhns). Plants large, vigorous, not diseased; leaflets large, dark; flowers perfect; trusses large, drooping, many flowered; berry uniform, ridged, wedge-shaped, irregular rough ovate, large to very large, dull scarlet; flesh light red, firm, juicy, rather acid, fair; core pink, soft; calyx large; separates easily; seeds many, small, bright.

Blaine, S—(M. Crawford Co.). Plants large, vigorous, diseased; leaflets large, dark; flowers perfect; trusses large, erect; berry uniform, ridged, sometimes hardnosed, roundish, medium to large, dull scarlet; flesh red, firm, juicy, subacid, fair; core pink, solid; calyx large, separates easily; seeds many, small.

Bradley, S—(W. F. Allen). Plants small, vigorous; leaflets large, dark; flowers perfect; trusses large, not erect; berry uniform, short conic, blunt, medium size, crimson; flesh light red, firm, juicy, subacid, fair; core red, solid; calyx medium, separates easily; seeds many.

Charles Newman, S—(Louis Hubach). Plants small, vigorous; leaflets small, dark; flowers perfect; trusses large, erect; berry uniform, roundish, blunt, slightly irregular, medium size, rich crimson; flesh red, firm, mild subacid, nearly sweet, fair; core red, not solid; calyx medium, adherent; seeds many.

Chesapeake, S—(W. F. Allen). Plants large and vigorous; leaflets large, dark; flowers perfect; trusses short, erect, many flowered; berry uniform, round-conic, often flattened at apex, large to very large, rich scarlet, slightly pitted; flesh light red, firm, juicy, pleasant mild subacid, excellent; core pink, solid; calyx large, persistent, segments long, broad; seeds many, large and conspicuous. One of the very best late varieties.

Chipman, S—(W. F. Allen). Plants moderately large and vigorous; leaflets large, dark; little disease; flowers perfect; trusses large, not erect, many flowered; berry uniform, very slightly necked, round-conic, medium to large, crimson; flesh light red, firm, not juicy, mild subacid, fair; core pink, solid; calyx large, persistent, diseased; seeds many.

Clara, S—(J. E. Kuhns). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses medium, drooping, many flowered; berry uniform, mostly conic, a little irregular, very large, rich scarlet, slightly pitted; flesh rich red, firm, juicy, mild subacid, fair to good; core pink, solid; calyx medium, separates easily; seeds many, large.

Clark Seedling, S—(Moore & Simon). Plants large, vigorous, considerable disease; leaflets large, dark; flowers perfect; trusses large, drooping; berry roundish conic, flattened, irregular, medium to vey large, bright scarlet; flesh white, firm, juicy, mild subacid, nearly sweet, fair; core pink, soft; calyx large, persistent; seeds many, large.

Colossus, P—(W. F. Allen). Plants small, vigorous; leaflets small, dark; flowers imperfect; trusses short, not erect; berry uniform, round, blunt, flattened, somewhat irregular, medium to large, bright scarlet; flesh rich red, firm, moderately juicy, mild subacid, fair; core red, solid; calyx medium, separates easily; seeds many.

Columbia, P—(M. Crawford Co.). Plants very large, vigorous; leaflets large, dark; flowers imperfect; trusses large, erect, many flowered; berry uniform, large, roundish-conic, cordate, tip often flattened, rich crimson, slightly pitted; flesh red, firm, juicy, mild subacid, fair; core light red, solid; calyx large, separates easily; seeds many, small.

Cooper, S—(M. Crawford Co.). Plants small, vigorous, leaflets small, light, flowers perfect; trusses short, drooping; berry uniform, sometimes necked, oblong-conic, medium, rich bright crimson; flesh light red, firm, juicy, mild subacid, good; core pink, soft; calyx medium, separates easily; seeds many, large.

Corsican, P—(Moore & Simon). Plants large, vigorous; leaflets large, light; flowers imperfect; trusses short, drooping; berry uniform, medium size, roundish-wedge-shaped, dark scarlet; flesh light red, moderately firm, juicy, mild subacid, fair; core pink, solid; calyx small, persistent; seeds many.

Dicky, S—(W. F. Allen). Plants small, vigorous; leaflets small, dark; flowers perfect; trusses large, erect; berry uniform, long conic, often flattened, large, rich bright crimson, slightly pitted; flesh rich red, firm, juicy, subacid, fair; core red, not solid; calyx medium, separates easily; seeds many.

Dighton Rock, S—(J. E. Kuhns). Plants large, vigorous; leaflets moderately large, light; flowers perfect; trusses small, not erect; berry uniform, round, medium to large, crimson; flesh red, firm, juicy, pleasant subacid, nearly sweet, fair; core pink, not solid; calyx, large, separates easily; seeds many.

Dixon, S—(James H. Gregory & Sons). Plants small, vigorous, considerable disease; berry roundish, wedge shaped, flattened, large, dark crimson; flesh red, firm, rather dry, mild subacid, fair; core red, solid; calyx small.

Dornan, S—(R. M. Kellogg Co.). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, drooping; berry not uniform, necked, ridged, roundish wedge-shaped, very irregular, sometimes angular, medium to very large, light scarlet; flesh light pink, not firm, rather dry, mild subacid, fair; core pink, solid; calyx medium, separates easily; seeds many, small.

Downing Bride, P—(R. M. Kellogg Co.). Plants medium large, moderately vigorous; leaflets large, dark; flowers imperfect; trusses short, drooping; berry uniform, oval, small, light and dark scarlet, very slightly pitted; flesh pink, firm, juicy, subacid, fair; core pink, soft; calyx small, persistent; seeds many, large.

Earliest of All, S—(Moore & Simon). Plants very large, vigorous; flowers perfect; trusses large, erect; berry uniform, slightly ridged, roundish-conic, wedge shaped, blunt, flattened, very large, scarlet; flesh pink, firm, juicy, mild subacid, fair; core pink, solid; seeds many, large.

Early Harvest, P—(Louis Hubach). Plants very large, vigorous; leaflets large, dark; flowers imperfect; trusses large, not erect; berry uniform, roundish, blunt, medium, dark crimson, flesh red, not firm, juicy, subacid, fair; core white, solid; calyx large, diseased; seeds many.

Early Miller, S—(E. W. Townsend & Co.). Plants large, vigorous; leaflets medium size, dark; flowers perfect; trusses medium length, drooping; berry uniform, conic, sometimes flattened, medium size, bright scarlet; flesh red, moderately firm, juicy; flavor pleasant subacid, nearly sweet; quality good; core pink, solid; calyx medium size, adherent; seeds many.

Early Ozark, S—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses medium, erect; berry not uniform, sometimes hard-nosed, roundish-oval, flattened, irregular, large to very large, bright crimson, flesh dark red, firm, juicy, mild subacid, nearly sweet, good; core red, soft; calyx large, persistent; seeds many.

Empress, S—(M. Crawford Co.). Plant medium large, vigorous; leaflets small, dark; flowers perfect; trusses medium, drooping, many flowered; berry uniform, cordate, irregular, medium large, dull crimson, slightly pitted; flesh light pink, not firm, juicy, rich pleasant subacid, nearly sweet, good; core pink, solid; calyx large, diseased; seeds many.

Enhance, S—(W. F. Allen). Plants vigorous; leaflets small, light; flowers perfect; trusses short, erect; berry uniform, conic, medium to large, scarlet; flesh red, firm, juicy, mild subacid, fair; core pink, solid; calyx medium, separates easily; seeds many, large.

Evening Star, S—(M. Crawford Co.). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, drooping; berry uniform, roundish, wedge shaped, blunt, medium to very large, light dull crimson; flesh light red, firm, rather dry, pleasant subacid, vinous, good; core pink, solid; calyx large, persistent; seeds many.

Fendall, P—(C. E. Fendall). Plants very large, vigorous; leaflets large, dark; flowers imperfect, trusses large, not erect; berry not uniform, round-conic, wedge-shaped, oblong, flattened, very large, light scarlet; flesh light red, not firm, juicy, mild subacid, fair; core white, moderately solid; calyx medium, separates easily; seeds many.

First Prize, S—(E. W. Townsend & Co.). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, erect; berry uniform, roundish, irregular, flattened, large, light crimson and scarlet; flesh light pink, moderately firm, juicy, mild subacid, fair; core white, solid; calyx large, separates easily; seeds many.

First Quality, S—(M. Crawford Co.). Plants very large, vigorous, leaflets large, dark, flowers perfect; trusses large, drooping, many flowered; berry uniform, oval, sometimes pointed, moderately large, rich bright scarlet, slightly pitted; flesh light red, firm, juicy, pleasant mild subacid, nearly sweet, good; core white, moderately solid; calyx large, separates easily; seeds many, large.

Florella, S—(W. F. Allen). Plants small, vigorous; leaflets large, dark; flowers perfect; trusses short, drooping; berry uniform, ridged, roundish, flattened, medium to large, crimson; flesh pink, moderately firm, juicy, mild subacid, fair; core pink, solid; calyx large, persistent; seeds many, small.

Fremont Williams, S—(W. F. Allen). Plants small, vigorous; leaflets large, light; flowers perfect; trusses short, not erect; berry uniform, ridged, conic, large, dark crimson; flesh light red, firm, juicy, watery subacid, fair; core white, solid; calyx large, separates easily.

Gandy, S—(Station Plot). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, erect; berry uniform, roundish-oval, flattened tip, large, rich scarlet; flesh rich red, firm, juicy, pleasant subacid, fair; core pink, not solid; calyx large, separates easily; seeds many.

Garrison, S—(J. E. Kuhns). Plants small, moderately vigorous; leaflets small, dark; flowers perfect; trusses very short, erect, many flowered; berry uniform, oblong, blunt pointed, irregular, medium, dull crimson, very slightly pitted; flesh light pink, firm, juicy, nearly sweet, fair; core white, solid; calyx medium, separates easily; seeds many, small.

Gem, S—Plants medium, vigorous; leaflets medium, dark; flowers perfect; trusses large, drooping; berry uniform, conic, sometimes roundish, rather large, dull scarlet; flesh white, moderately firm, rather dry, mild subacid, fair; core white, soft; calyx medium, persistent; seeds few, large.

Gill, S—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, erect, many flowered; berry uniform, round conic to wedged-shaped, blunt, irregular, medium, crimson, slightly pitted; flesh light red, firm, subacid, fair; core pink, not solid; calyx medium, separates easily; seeds many.

Gold Dollar, S—(M. Crawford Co.). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses medium, erect; berry uniform, roundish-conic, irregular, very large, dark crimson; flesh rich red, firm, juicy, pleasant subacid, good; core pink, solid; calyx very large, persistent.

Golden Gate, P—(W. F. Allen). Plants small, vigorous; leaflets small, dark; flowers imperfect; trusses short, not erect, many flowered; berry not uniform, necked, round oval, blunt, often flattened, large, dull crimson; flesh light red, firm, juicy, pleasant subacid, nearly sweet, fair; core pink, solid; calyx large, separates easily; seeds many.

Goldsborough, S—(A. T. Goldsborough). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, erect; berry uniform, roundish-ovate, flattened tip, very large, rich bright crimson, slightly pitted; flesh rich red, firm, not juicy, pleasant subacid, nearly sweet, good; core pink, solid; calyx large, separates easily; seeds many, large.

Good Luck, S—(W. F. Allen). Plants large, vigorous, considerable disease; leaflets small, dark; flowers perfect; trusses large, not erect; berry not uniform, ridged, irregular, roundish, flattened, coxcombed, large to very large, crimson; flesh red, firm, juicy, subacid, fair; core white, solid; calyx large, separates easily; seeds many.

Gorce, S—(M. Crawford Co.). Plants medium large, moderately vigorous; leaflets large, dark; flowers perfect; trusses medium, drooping, many flowered; berry uniform, short conic, medium size, rich dark scarlet, very slightly pitted; flesh dark red, firm, juicy, pleasant mild subacid, good; core pink, solid; calyx small, separates easily; seeds many, bright.

Governor Rollins, S—(W. F. Allen). Plants large, vigorous; leaflets large, dark; trusses short, erect, many flowered; berry uniform, round conic, sometimes flattened and irregular, medium to large, rich crimson, slightly pitted; flesh rich red, firm, juicy, pleasant mild subacid, fair; core red, not solid; calyx large, adherent; seeds many.

Great Ruby, S—(Peter Henderson Co.). Plants large, vigorous, not diseased; leaflets large, dark; flowers perfect; trusses short, erect, many flowered; berry uniform, ridged, roundish-conic, sometimes approaching wedge-shape, above medium, bright and dark scarlet; flesh dark red, very firm, juicy, pleasant mild subacid, fair; core white, solid, sometimes hollow; calyx medium, persistent; seeds many, small, dark.

Great Scott, P—(W. F. Allen). Plants large, vigorous; leaflets large, light; flowers imperfect; trusses large, not erect, many flowered; berry uniform, wedge-shaped, flattened, sometimes doubled, large, crimson; flesh pink, pleasant mild subacid, fair; core white, solid, sometimes hollow; calyx medium, persistent; seeds many, small, dark.

Greenville, P—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses short, drooping; berry not uniform, ridged, conic, large, dark scarlet; flesh red, not firm, juicy, subacid, fair; core red, pleasant subacid, nearly sweet, good; core red, solid; calyx medium, persistent; seeds many, large.

Helen Gould, P—(W. F. Allen). Plants small, vigorous; leaflets large, dark; flowers imperfect; trusses short, not erect; berry uniform, slightly ridged, conic, sometimes flattened, medium to large, bright, scarlet; flesh light red, not firm, juicy, watery, subacid, fair; core white, solid; calyx large, separates easily.

Heritage, S—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, erect; berry uniform, ridged, long conic to long wedge-shaped, medium to very large, dull crimson; flesh pink, firm, moderately juicy, subacid, fair; core white, soft; calyx very large, persistent; seeds many, medium size.

Highland, P—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses large, drooping; berry uniform, roundish-conic, flattened, large, bright scarlet; flesh red, soft, juicy, subacid, fair; core red, solid; calyx large, separates easily; seeds many, small.

Holland Seedling, S—(Chas. A. Holland). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses short, erect; berry uniform, round conic, large, dark scarlet; flesh red, not firm, juicy, subacid, fair; core red, not solid; calyx large, separates easily; seeds many.

Howard 17, S—(A. B. Howard & Son). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, drooping; berries uniform, necked, long conic, roundish, slightly flattened, medium to very large, light scarlet; flesh pink, moderately firm, mild subacid, fair; core white, solid, calyx large, separates easily; seeds many, large.

Hustler, P—(H. L. Crane). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses short, drooping; berry uniform, conic, large to very large, dark scarlet; flesh pink, moderately firm, juicy; flavor mild subacid; quality fair; core pink, solid; calyx large, separates easily.

Ionian Market, P—Plants small, vigorous; leaflets small, dark; flowers imperfect; berry uniform, necked, roundish-conic, sometimes flattened, medium to large, bright crimson; flesh pink, soft, juicy, mild subacid, fair; core pink, solid; calyx large, persistent; seeds many.

Island King, S—(M. Crawford Co.). Plants medium, moderately vigorous; leaflets small, dark; flowers perfect; trusses short, drooping, many flowered; berry uniform, roundish-conic, irregular, medium to large, dark crimson, slightly pitted; flesh red, firm, juicy, mild subacid, fair to good; core light red, solid; calyx large, separates easily; seeds many.

Jim Dumas, S—(Louis Hubach). Plants large, vigorous, some disease; leaflets small, dark; flowers perfect; trusses large, not erect; berry uniform, ridged, conic, blunt, somewhat irregular, medium to large, scarlet; flesh a good red, firm, quite juicy, mild acid, fair quality; core red, solid; calyx large, persistent; seeds many, large, bright.

July, P—(H. J. Schild). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses large, not erect; berry uniform, conic, medium to large, rich bright scarlet; flesh light red, firm, juicy, sharp subacid, fair; core red, not solid; calyx very large, separates easily; seeds many.

Keavitt Wonder, S—(W. F. Allen). Plants small, vigorous; very little disease; leaflets small, dark; flowers perfect; trusses small, drooping, many flowered; berry fairly uniform, necked, long flattened or cylindrical, medium, light to dark crimson; flesh pink, firm, moderately juicy, mild subacid, fair; core white, solid; calyx medium, separates easily.

King Edward, S—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, drooping; berry uniform, somewhat ridged, cordate, medium to large in size, dull crimson; flesh white tinged with red, moderately firm, juicy; flavor nearly sweet; quality fair; core pink, solid; calyx large, does not separate easily; seeds many, small.

Lady Finger, S—(R. Vincent, Jr. & Sons). Plants large, vigorous; leaflets large, light; flowers perfect; trusses large, drooping; berry uniform, somewhat necked and ridged, roundish-conic, often flattened, medium, dark crimson; flesh red, moderately firm, juicy, pleasant, nearly sweet, good; core red, solid; calyx large, segments long, separates easily; seeds many.

Lady Townsend, S—(E. W. Townsend & Co.). Plants moderately large, moderately vigorous; flowers perfect; trusses medium, erect; berry uniform, long conic, medium size, dark crimson, minutely pitted; flesh red, firm, moderately juicy, sharp subacid, fair; core white, solid; calyx large, separates easily; seeds many.

Laxton Commander, P—(A. T. Goldsborough). Plants large, vigorous; leaflets large, light; flowers imperfect; trusses small, not erect; berry not uniform, conic, flattened, rough, irregular, large, rich dark scarlet, slightly pitted; flesh light red, firm, rather dry, mild subacid, fair; core pink, not solid; calyx medium, adherent; seeds many, small.

Lea, S—(W. F. Allen). Plants medium large, vigorous; leaflets large, dark; flowers perfect; trusses large, drooping, many flowered; berry uniform, roundish-conic, medium size, dull scarlet; flesh light red, firm, juicy, rather subacid, flat, fair; core white, solid; calyx large, separates easily; seeds many. bright.

Lester Lovett, S—(Station Plots). Plants large, vigorous; leaflets large, light colored; flowers perfect; trusses large, erect; berry uniform, ridged, roundish-conic, blunt, flattened, slightly pitted, large, rich scarlet and crimson; flesh light red, firm, juicy; flavor mild subacid; quality fair to good; core pink, soft; calyx very large, separates easily; seeds many.

Little Jap, S—(A. T. Goldsborough). Plants large, vigorous, somewhat diseased; leaflets large, dark; flowers perfect; trusses short, erect; berry uniform, roundish, flattened, coxcombed, medium to large in size, bright crimson, slightly pitted; flesh light red; firm, juicy; flavor mild subacid; quality fair; calyx large, does not separate easily; seeds many, large, bright.

Livingston, S—(J. G. Harrison & Sons). Plants large, vigorous, some disease; leaflets small, dark; flowers perfect; trusses large, erect; berry not uniform, necked, conic, flattened, irregular, medium size, rich crimson; flesh light red, not firm, juicy, subacid, nearly sweet, fair; core pink, not solid; calyx medium, separates easily; seeds many.

Longfellow, S—(R. M. Kellogg & Co.). Plants moderately large, vigorous leaflets medium, light; flowers perfect; trusses large, somewhat erect, many flowered; berry nearly uniform, more or less necked, flattened, somewhat ridged, roundish-conic somewhat constricted toward apex, medium to large, bright dark crimson, slightly pitted; flesh light red, moderately firm, juicy, pleasant mild subacid, fair; core light pink, solid, calyx large, separates easily; seeds many.

Longworth, P—(A. T. Goldsborough). Plants very large, vigorous; leaflets large, dark; flowers imperfect; trusses large, not erect; berry not uniform, round, flattened, irregular, very large, rich bright crimson and scarlet; flesh pink, firm, juicy, watery subacid, fair; core white, not solid; calyx large, separates easily; seeds many.

Louis Gaulthier, S—(A. T. Goldsborough). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses short, not erect, many flowered; berry uniform, round conic to conic flattened, medium to large, crimson; flesh rich red, firm, not juicy, pleasant subacid, nearly sweet, good; core red, moderately firm; calyx large, separates easily; seeds many, large.

Mammoth Beauty, P—(W .F. Allen). Plants small, vigorous; leaflets small, dark; flowers imperfect; trusses short, not erect; berry uniform, ovate-pointed, large, bright crimson, slightly pitted; flesh rich red, firm, juicy, mild subacid, fair; core red, not solid; calyx medium, separates easily; seeds many.

Manhattan, S—(J. E. Kuhns). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses short, erect, many flowered; berry uniform, rough, irregular, roundish-truncate, large to very large, dull crimson, very slightly pitted; flesh pink, firm, juicy, mild subacid, nearly sweet, fair; core white, solid; calyx large; adherent; seeds many, large.

Margaret, S—(M. Crawford Co.). Plants large, vigorous; flowers perfect; trusses large, drooping; berry not uniform, ridged, conic to coxcomb, medium to very large, dark crimson; flesh pink, moderately firm, juicy, mild subacid, fair; core white, solid; calyx large, persistent; seeds many, large.

Maryland, S—Plants large, vigorous; leaflets small, dark; flowers perfect; trusses large, drooping; berry uniform, ridged, roundish-conic, blunt, flattened, irregular, large to very large, bright scarlet; flesh almost white, moderately firm, juicy, mild subacid, nearly sweet; core pink, solid; calyx large, persistent; seeds many, small.

Mascot, S—(J. G. Harrison & Sons). Plants small, vigorous; leaflets small; flowers perfect, trusses short, drooping; berry not uniform, slightly necked, ridged, roundish-blunt, flattened, irregular, large, scarlet; flesh pink, moderately firm, juicy, mild subacid, good; core pink, solid; calyx large, segments long, separates easily; seeds many.

Matthew Crawford, S—(M. Crawford Co.). Plants small, vigorous; leaflets large, dark; flowers perfect; trusses short, drooping; berry uniform, conic, wedge-shaped, irregular, medium to large, light scarlet; flesh white to light red, moderately firm, juicy, mild subacid, fair; core white, solid; calyx small, persistent; seeds many, large.

Meek Early, S—(J. E. Kuhns). Plants large, very vigorous, not diseased; leaflets large, dark; flowers perfect; trusses large, erect, many flowered; berry uniform, slightly necked, roundish-conic, often flattened, small to medium, bright scarlet; flesh light pink, moderately firm, juicy, pleasant mild subacid, nearly sweet, good; core white, solid; calyx large, separates easily; seeds many, bright.

Meteor, P—(J. E. Kuhns). Plants large, vigorous; leaflets small, dark; flowers imperfect; trusses large, drooping, many flowered; berry uniform, somewhat ridged, conic, cordate, medium to large, bright dark scarlet; flesh light pink, moderately firm, juicy, pleasant subacid, fairly good; core white, solid; calyx large, does not separate easily; seeds many.

Miller, S—(M. Crawford Co.). Plants small, vigorous; leaflets large, dark; flowers perfect; trusses large, few flowered; berry uniform, roundish-conic, blunt, medium to large, bright crimson; flesh white, firm, juicy, nearly sweet, good; core pink, soft; calyx medium, separates easily.

Missionary, S—E. W. Townsend & Co.). Plants large, moderately vigorous; leaflets large, dark; flowers perfect; trusses small, drooping, many flowered; berry uniform, roundish-conic, constricted apex, medium size, very dark scarlet; flesh dark red, firm, moderately juicy, subacid, bitter, poor; core red, solid; calyx medium, separates easily; seeds many.

Morning Star, S—(W. F. Allen). Plants small, not vigorous; leaflets small, dark; flowers perfect; trusses large, not erect; berry uniform, roundish-oval, sometimes flatttened and irregular, large, rich crimson; flesh rich dark red, not firm, not juicy, rather pleasant mild subacid, fair; core red, moderately solid; calyx large, separates easily; seeds many.

Mrs. Miller, P—(M. Crawford Co.). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses large, drooping; berry uniform, some times necked, long wedge-shaped, irregular, medium to large, dull scarlet; flesh light red, firm, juicy, subacid, flat, fair; core pink, solid; calyx medium, persistent; seeds many, large.

Mrs. Miller, P—(J. E. Kuhns). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses large, not erect, many flowered; berry uniform, irregular, rough, roundish-oblong, medium to large, scarlet; flesh red, not firm, juicy, acid, fair; core pink, solid; calyx large, separates easily; seeds many.

Myer, P—Plants large, vigorous; leaflets small, dark; flowers perfect; trusses short, erect; berry uniform, conic, slightly flattened, medium to large, light crimson; flesh white, soft, juicy, mild subacid, fair; core white, solid, calyx medium, does not separate easily; seeds many, large.

Nettie, P—(Station Plot). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses large, erect; berry necked, long oval, wedge-shaped, flattened, irregular, very large, dull scarlet; flesh light red, firm, juicy, watery subacid, fair; core white, solid; calyx medium, separates easily; seeds many.

North Shore, S—(Station Plot). Plants large, moderately vigorous; leaflets large, light; flowers perfect; trusses erect, many flowered; berry uniform, slightly necked, somewhat ridged, conic to pointed-oval, medium to large, dark scarlet; flesh rich red, firm, moderately juicy, pleasant mild subacid, fair; core red, solid; calyx large, separates easily, diseased; seeds many, large.

Norwood, S—(M. Crawford Co.). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, drooping; berry uniform, roundish-conic, often flattened, medium to very large, dark rich scarlet flesh dark red, firm, juicy, mild subacid, rather pleasant, fairly good; core pink, soft, calyx small, separates easily.

Oregon Ironclad, S—(R. M. Kellogg & Co.). Plants large, vigorous; leaflets small, light; flowers perfect; trusses short, drooping; berry uniform, slightly necked, roundish-conic, flattened, irregular, medium to large, rich scarlet; flesh red, firm, juicy, mild subacid, good; core red, solid; calyx small, separates easily.

Orem, S—(J. G. Harrison & Sons). Plants quite large, vigorous; leaflets large, dark; flowers perfect; trusses large, not erect; berry uniform, sometimes necked, ridged, conic, flattened, very large, dull scarlet; flesh light red, firm, juicy, subacid, fair; core pink, solid, dry; calyx large, adherent; seeds many.

Oswego, S—(W. F. Allen). Plants moderately large and vigorous; leaflets large, dark, some disease; flowers perfect; trusses small, erect, many flowered; berry uniform, roundish to long oval, blunt, medium to large, light scarlet; flesh light red, firm, not juicy, mild subacid, fair; core pink, solid; calyx medium, separates easily, diseased; seeds many, large, dark.

Outlander, P—(A. T. Goldsborough). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses large, erect; berry uniform, ovate, flattened, very large, rich crimson; flesh rich red, firm, juicy, very pleasant mild subacid, excellent; core red, not solid; calyx large, separates easily; seeds many.

Pennsylvania Dutchman, S—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, not erect, many flowered; berry uniform, sometimes necked, round-conic, flattened, medium to large, crimson; flesh light red, firm, not juicy, very mild subacid, fair; core pink, not solid; calyx large, separates easily; seeds many.

Paul Jones, P—Plants large, moderately vigorous; leaflets small, light; flowers imperfect; trusses large, erect; berry uniform, ridged, roundish-oval, blunt, flattened, pointed, large, crimson; flesh light red, soft, juicy, mild subacid, fair; core white, solid; calyx large, separates easily; seeds many, large,

Pennell, S—Plants small, moderately vigorous; leaflets large, dark, flowers perfect; trusses short, drooping; berry uniform, ridged, roundish-conic, blunt, flattened, medium to very large, dark scarlet; flesh red, firm, juicy, pleasant, nearly sweet, fair to good; core red, solid; calyx large, separates easily; seeds many.

Pineapple, S—(Moore & Simon) Plants large, vigorous, considerable disease; flowers perfect; trusses large, erect; berry uniform, roundish-wedge-shaped, coxcombed, very irregular, medium to very large, scarlet; flesh light red, firm, juicy, acid, flat, fair; core pink, solid; calyx large, persistent; seeds many, small.

Pocahontas, S—(W. F. Allen). Plants moderately large and vigorous; leaflets large, dark, very little disease; flowers perfect; trusses large, erect, many flowered; berry uniform, slightly necked, roundish-conic to oval, blunt, medium or above, dark scarlet; flesh pink, moderately firm and juicy, mild subacid, fair; core red, not solid; calyx large, separates easily; seeds many, medium size.

President, S—(W. F. Allen). Plants small, not vigorous, considerably diseased; leaflets large, dark; flowers perfect; trusses short, drooping; berry uniform, conic, flattened, irregular, medium, rich scarlet; flesh red, firm, juicy, pleasant mild subacid, good; core pink; solid; calyx small, persistent.

Pride of Michigan, S—(J. E. Kuhns). Plants large, vigorous; leaflets large, light; flowers perfect; trusses large, not erect; berry not uniform, sometimes necked, irregular, roundish-conic, flattened, large, dark crimson; flesh red, firm, rather dry, nearly sweet, fair; core red, not solid; calyx medium, separates easily; seeds many.

Prof. Fischer, P—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses short, not erect; berry not uniform, ridged, roundish, irregular to coxcombed, very large, bright crimson; flesh red, firm, juicy, subacid, fair; core red, very soft; calyx large, separates easily.

Prolific, S—(J. E. Kuhns). Plants large, vigorous, slightly diseased; leaflets large, dark; flowers perfect, trusses large, erect, many flowered; berry uniform, somewhat irregular, roundish-cordate, truncate, large to very large, rich bright dark scarlet, slightly pitted; flesh rich red, moderately firm, very juicy, pleasant mild subacid, vinous, good; core pink, solid; calyx large, adherent; seeds many, large.

Reba, P—(Wm. Henry Maule). Plants medium, moderately vigorous; leaflets large, dark; flowers imperfect; trusses short, drooping; berry uniform, roundish, medium, dull crimson; flesh pink, firm, juicy, pleasant subacid, fair; core light pink, solid; calyx medium; seeds many, large.

Red Bird, P—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses short, not erect; berry uniform, round-conic, blunt, flattened, irregular, medium to large, rich dark crimson; flesh rich red, firm, juicy, subacid, flat, fair; core red, solid; calyx large, separates easily; seeds many.

Ryckman, S—(J. E. Kuhns). Plants large, vigorous; leaflets large, light; flowers perfect; trusses short, not erect; berry not uniform, ovate, roundish, flattened, irregular, medium to large, light scarlet; flesh light red, firm, not juicy, nearly sweet, flat, fair; core pink, not solid; calyx medium, adherent.

Saunders, S—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, drooping, many flowered; berry not uniform, ridged, roundish-conic, flattened, medium to very large, crimson; flesh light red, soft, juicy, subacid, fair; core white, solid; calyx medium, persistent; seeds many, small.

St. Louis, S—(J. G. Harrison & Sons). Plants large, vigorous, some disease; leaflets small, dark; flowers perfect; trusses large, not erect; berry uniform, necked, conic, blunt, medium to large, crimson; flesh pink, moderately firm, not juicy, pleasant mild subacid, nearly sweet, quality fair; core pink, not solid; calyx medium, separates easily.

Saratoga, S—(W. F. Allen). Plants small, not vigorous; leaflets large, dark; flowers perfect; trusses short, not erect; berry uniform, conic, flattened, irregular, medium to large, dull crimson; flesh red, firm, juicy, subacid, fair; pink, not solid; calyx medium, separates easily.

Shipping King, S—(W. F. Allen). Plants moderately large, vigorous; leaflets medium, light; flowers perfect; trusses small, not erect; berry uniform, round-conic, flattened, medium, bright dark scarlet; flesh red firm, juicy, pleasant mild subacid, good; core red, solid; calyx medium, separates easily

Sunshine, S—(J. E. Kuhns). Plants large, vigorous, some disease; leaflets moderately large, dark; flowers perfect; trusses short, erect; berry uniform, ridged, roundish-oval, blunt, sometimes flattened, medium size, bright crimson; slightly pitted; flesh pink, firm, moderately juicy, subacid, fair; core pink, solid; calyx large, separates easily; seeds many, small.

Swedenborg, S—(David Knight & Son). Plants large, vigorous, much diseased; leaflets large, dark; flowers perfect; trusses large, drooping; berry uniform, roundish, medium to very large, light crimson; flesh light pink, soft, juicy, mild subacid, flat, fair; core white, solid; calyx medium, separates easily.

Taft, P—(A. T. Goldsborough). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses short, not erect; berry uniform, short-conic, flattened, large, rich scarlet; flesh rich red, firm, juicy, mild subacid, fair; core red, solid; calyx large, adherent; seeds many.

Texas, S—(W. F. Allen). Plants medium large, rather vigorous; flowers perfect; trusses small, drooping, many flowered; berry uniform, roundish, slightly conic, medium, dull crimson, very slightly pitted; flesh white tinged with red, firm, moderately juicy, watery acid, fair; core white, solid; calyx small, persistent; seeds many, dark.

Three Ws, S—(W. F. Allen). Plants large, vigorous; leaflets small, dark; flowers perfect; trusses large, not erect; berry uniform, slightly necked, roundish, oblong-flattened, irregular, medium to large, light crimson, slightly pitted; flesh red, firm, not juicy, pleasant mild subacid, fair; core red, not solid; calyx medium, separates easily; seeds many.

Trilley, S—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers perfect; trusses large, drooping, many flowered; berry uniform, somewhat ridged, oblong, truncate, medium, bright crimson, slightly pitted; flesh light red, moderately firm, moderately juicy, pleasant subacid, fair; core pink, solid; calyx very large; segments very long, separates moderately easy; seeds many.

Velvet, P—(W. F. Allen). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses short, not erect; berry uniform, roundish, flattened, medium to large, dark crimson; flesh red, firm, juicy, mild subacid, fair; core red, solid; calyx small, persistent; seeds many.

Victor, S—(W. F. Allen). Plants large, vigorous; leaflets small, dark, flowers perfect; trusses short, erect; berry not uniform, roundish-conic, irregular, coxcombed, large to very large, dark scarlet; flesh light red, firm, juicy, mild subacid, fair; core soft; calyx large, separates easily; seeds many, large.

Virginia, S—(W. F. Alleu). Plauts large, moderately vigorous; leaflets small, dark; flowers perfect; trusses short, not erect, many flowered; berry uniform, roundish-oval, blunt, medium to large, crimson; flesh red, firm, not juicy, acid, fair; core pink, solid; calyx medium, adherent; seeds many, large, dark.

Waldorf, S—Vaughns Seed Store). Plants vigorous; leaflets small, light; flowers perfect; trusses short, drooping; berry uniform, some slightly necked, roundish-conic, blunt, large, scarlet; flesh pink, soft, juicy, nearly sweet, fair; core pink, solid; calyx large, separates easily; seeds many.

Winchell Beauty, P—(J. E. Kuhns). Plants large, vigorous; leaflets large, dark; flowers imperfect; trusses large, not erect, many flowered; berry uniform, ridged, round-conic, medium to large, bright crimson; flesh pink, firm, not juicy, subacid, fair; core pink, not solid; calyx large, separates easily; seeds many, small.

Wine, S—(E. W. Townsend & Co.). Plants large, vigorous, not diseased; leaflets small, dark; flowers perfect; trusses short, drooping, many flowered; berry uniform, slightly pitted, ridged, roundish-cordate, flattened at end, medium, rich light and dark scarlet; flesh light red, moderately firm, juicy, subacid, fair; core red, solid; calyx medium, separates easily; seeds many.

Wonder, S—(J. E. Kuhns). Plants moderately large, vigorous, leaflets medium, light; flowers perfect; trusses short, not erect; berry not uniform, some slightly necked, round-conic, blunt, flattened, irregular, medium to large, light scarlet; flesh light red, firm, not juicy, mild subacid, fair; core red, not solid; calyx medium, separates easily; seeds many.

Wooster, P—(M. Crawford Co.). Plauts large, vigorous; leaflets large, dark; flowers imperfect; trusses large, drooping, many flowered; berry uniform, roundish-conic, very large, bright crimson; flesh pink, moderately firm, juicy, pleasant mild subacid, good; core white, solid; calyx large, persistent; seeds many, large.

World Champion, S—(James J. H. Gregory & Sons). Plants small, moderately vigorous; leaflets small, light; flowers perfect; trusses short, drooping, many flowered; berry roundish, blunt, irregular, medium dark scarlet; flesh red, firm, juicy, subacid, fair; core red, solid; calyx small, persistent.

STRAWBERRY DISEASES*

The strawberry is not troubled much by diseases. There are three species of fungi that cause leaf spot; the most common one being *Sphaerella fragariae*. The small purple or red bordered spots on the leaves are familiar to all growers. They often, especially in susceptible varieties like Warfield, Gandy, Bubach, Haverland, etc., destroy enough of the foliage to greatly reduce the vitality of the plants. Moisture and heat favor the disease, especially when followed by dry weather, and it is worse on heavy wet soil. Hume reports Lady Thompson and Michel Early as quite resistant.

Frequent spraying with Bordeaux mixture will control the disease.

Powdery mildew often causes a curling of the leaves, but is usually not troublesome.

INSECTS AFFECTING THE STRAWBERRY.*

Strawberries can be considered fairly immune from severe insect attack. While there are several pests that occasionally do serious injury, their attack is usually somewhat local and seldom threatens the whole crop, although all the pests are difficult to control.

The following records the principal species that may be considered pests in this State:

THE STRAWBERRY ROOT LOUSE.
(*Aphis forbesi Weed.*)

This is probably the most generally distributed insect pest of this plant in the State. It is a small, dark green aphis that feeds on the roots of the plant. The aphis winters usually in the egg state, these being laid on the stems or leaves in the fall. The eggs hatch in early spring and the young lice crawl to the roots, where they feed and reproduce. The insect often causes large barren places in a strawberry field.

REMEDY—All plants from an infested patch should be dipped in a strong solution of tobacco water before planting. Black leaf, a manufactured tobacco product, diluted at the rate of one part of Black Leaf to forty parts of water, is a convenient dipping wash. The liberal use of tobacco dust around the roots of the plants in the bed is a good preventive of injury from the pest. Also burning over strawberry patches in early spring, so that just the old leaves will be burned, is good practice, as the eggs of the aphis will be destroyed before hatching.

THE WHITE GRUB.
(*Lachnosterna arcuata Sm.*)

The grub worm as it is often called is at times a serious pest of strawberry plants. The larvae feed on the tender roots in the spring.

---

*By J. B. S. Norton.

*By T. B. Symons.

Remedy—There is practically nothing that can be done when the insect appears. Some growers seek the worms around the plants by hand, and destroy them, but when they are present in large numbers, this is a tedious and impractical task. The use of salty fertilizer such as Kainit has been recommended, but this will give only little relief.

The only preventive of injury is rotation of crops and avoiding planting strawberries on newly plowed sod land.

THE STRAWBERRY WEEVIL.

(*Anthonomus signatus Sm.*)

This is one of the most troublesome pests of the strawberry in several parts of the State. Its attack is somewhat periodic, as some years it causes more injury than others.

The adult insect is a small dark brown or black beetle, which winters in the adult state in any favored location, such as the border of a woods. It appears in early spring just before the blooming of strawberry plants. The female selects an unopened, nearly matured flower, which she perforates with her beak and then deposits her egg down in the bud. She then cuts the flower stalk in such a manner that it will fall over and hang by a mere thread or skin. The bud falls to the ground a little later and is kept moist, facilitating the growth of the larvae. The injury caused by the insect is the killing of so many flowers. Oftentimes, the crop of a certain variety will be reduced two-thirds by the work of this beetle.

Remedy—There is practically nothing that can be done for this pest when it occurs. Some relief may be secured by planting varieties which are profuse bloomers, and giving preference to those varieties which show least injury from the attack of the insect. The removal of all rubbish from around the patch and places where the adult beetle may hibernate will be beneficial.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 161, NOVEMBER, 1911.

TREATMENT FOR THE SAN JOSE SCALE AND TERRAPIN SCALE INSECTS.

By T. B. SYMONS, E. N. CORY and O. G. BABCOCK.

INTRODUCTION.

The purpose of this bulletin is to give the results of experiments conducted during the past year for the control of the San Jose and Terrapin Scale Insects.

The San Jose Scale situation has changed little since the publication of Bulletin No. 148, November, 1910. The progressive growers have long since ceased to fear the ravages of the insect, while the small growers or those who are not especially interested in their trees, either are not as yet familiar with it, or fail to give it any attention. There is, thus, opportunity for a great deal of good to be done by extension work in the control of scale insects in many parts of the State. The attendance and interest manifested at the spraying demonstrations conducted by this Department last Spring, indicate further need of such work.

The concentrated lime sulphur solution is now accepted as the most practical remedy for the pest. The interest of progressive growers is now centered on the comparative economy and practicability of the commercial product, as against the home-made concentrated solution and the determination of the best formula to be employed in preparing the latter. The experiments here reported were conducted with a view of securing this information as far as possible with our means.

The status of the Terrapin Scale in the State has greatly improved during the past year, due partly to natural parasites and partly to the heroic treatment given by those growers whose orchards were badly infested. This scale has not spread nearly as much in 1911 as in 1910, and the bad infestations so far as known, have been given very successful treatment. The experiments conducted against this pest were a continuation of those reported in Bulletin No. 150, and had in view the determination of the best remedy for the pest, which would also be safe to use on peach trees, the physiological effect on the tree as well as the insecticidal value of the spray being considered.

There are comparatively few people in the State who are as yet familiar with this scale, and it is probably more generally distributed than is now known. However, the work of the natural parasites, as revealed this year, if continued, will undoubtedly aid greatly in holding the pest in check where it occurs.

The Department abandoned testing the various proprietary solutions that have recently appeared in the market for the control of scale insects, believing that such work should only be done periodically in the future, if at all, and since the lime sulphur wash is so generally recognized as the best remedy, it is thought that no new remedy will supercede it.

The description and life history of the San Jose Scale and of the Terrapin Scale were given in Bulletins No. 148 and No. 150 respectively, and will not be given here. These bulletins may be had upon request to the Experiment Station.

The Department extends thanks to Messrs. C. W. Keller, of Harper's Ferry, W. Va., J. G. Harris, and A. L. Crewe, of Still Pond, and W. Frank Chaney, of Bristol, for the use of their orchards for these spraying tests, and gratefully acknowledges their cooperation, in the application of the spray mixtures.

SPRAYING TESTS FOR SAN JOSE SCALE.

The object of these tests was to determine the most satisfactory formula to use in making the home-made concentrated lime sulphur solution. Various formulas have been advocated by different stations, as the result of the chemical analyses showing the best proportions of lime and sulphur compounds of trial solutions. All were to be diluted, in accordance with the Hydrometer test of the concentrated, on basis of the density of the old home-made wash.

Fall Tests.

On November 23, 1910, six different solutions were sprayed on 114 bodly infested peach trees, in the "Keller" orchard. Of these, two were a standard commercial brand, which was used at two strengths. The other four included different proportions of lime and sulphur mixed after different formulas.

Three home-made solutions, Nos. 1, 2 and 3 in Table I, were made by first slacking the lime to a consistency of thin paste and then adding the sulphur and enough water to make about 55 gallons. The whole was then boiled for 50 minutes, thus reducing the quantity to about 50 gallons.

The solution No. 4 in Table I, was made in the same manner as preparing the old home-made lime sulphur, by the formula recommended in this State, viz.—By first bringing about 20 gallons of water to a boil, when the above lime and sulphur was added at the same time. The solution was then boiled for 50 minutes, water being added to bring the total to about 50 gallons at the end of boiling.

TABLE I—*Synopsis of Fall Tests.*

Lime Sulphur Solutions				Hydrometer test Beaume'	Dilution	Date of Application	No. of Trees Sprayed	Effect in Killing Scale 7/8/11
No.	Lime	Sulphur	Water					
1	50	75	50	22	1–4½	11/23/10	19	Excellent
2	60	125	50	33	1–8	11/23/10	19	Excellent
3	50	100	50	26.5	1–5¾	11/23/10	19	Good
4	50	100	50	28	1–6½	11/23/10	19	Excellent
5	Commercial Brand			33	1–9	11/23/10	19	Good
6	Check............			....	....	....	....	Scale all alive

RESULTS.

The results indicate practically no difference in the effectiveness of the various spray mixtures, all having been successful in controlling the scale. It is true that the past season has been a remarkably dry one in the vicinity of the "Keller" orchard, which may in part account for uniform good results from these Fall tests. It is also noted that the Fall application controlled the peach leaf curl to a remarkable degree in comparison with the check.

SPRING TESTS.

A greater number of solutions were employed in the Spring Tests. In all, nine different solutions were applied on 418 peach trees badly infested with San Jose Scale, in the "Keller" orchard.

The object of these tests was a continuation of the Fall work, in addition to employing various other combinations of materials. We also endeavored to see if continuous boiling would affect the density of the wash and its effect upon the scale. The same formulas as used in the Fall and the new formula suggested by the Geneva Station were made up as nearly in accordance with the Maryland method as the size of the boiling vats would allow. It was found that unless very large vats were used, when live steam is employed, that the previously heated water added so much violence to the slaking lime that losses by boiling over were frequent. All were made by putting the lime and sulphur simultaneously into about 30 gallons of water, turning in the live steam and as soon as the lime and sulphur became thoroughly mixed, adding sufficient water to make up 50 gallons. In Table II, a synopsis of this work is given, and it is not thought necessary to further elaborate on the different solutions.

TABLE II—*Synopsis of Spring Tests.*

Lime Sulphur Solutions					Hydrometer test Beaume'	Dilution	Date of Application	No. of Trees Sprayed	Effect in Killing Scale
No.	Lime	Sulphur	Water	Time Boiled					
1	50	100	50	1 hour	31°	1–7½	Mar. 27/11	32	Excellent
2	50	100	50	1 hour 1½ hour	25° 25°	1–5½	Mar. 27/11	53	Excellent
3*	50	100	50	1 hour	30°	1–7	Mar. 28/11	35	Excellent
4	60	125	50	1 hour	26°	1–6	Mar. 28/11	35	Excellent
5	60	125	50	1 hour 1¼ hour 1½ hour	28° 28° 28°	1–6½	Mar. 28/11	53	Excellent
6	36	80	50	1 hour	18°	1–4	Mar. 27/11	87	Excellent
7	36	80	50	1 hour 1½ hour 2 hour	18° 18° 18°	1–4	Mar. 28/11	53	Excellent
8	36	80	50	1 hour	25°	1–5½	Mar. 28/11	35	Excellent
9	36	80	50	1 hour	25°	1–5½	Mar. 28/11	35	Fair
....	.....	Checks.....		....	....	....	....	35	All scale alive

*—Hydrated Lime.

RESULTS OF SPRING TESTS.

As indicated in the table, the examination of trees sprayed with the different solutions, July 8, 1911, showed that practically all were successful in controlling the scale. The solution in which hydrated lime was used, gave the poorest results, but in this test only a few live scale could be found. On the check trees, the scale had bred and increased normally. The control of leaf curl was equally characteristic—about 1½ per cent. appearing on sprayed trees as compared with 85 per cent. on the check trees.

As a whole, the tests further demonstrated the ability of the lime-sulphur solution to control the scale under various conditions. It was found that continuous boiling of the material for 1½ or 2 hours did not materially increase the density. There was, however, considerable difference in the density of the solution,—the highest reading being given by those containing the larger amounts of lime and sulphur. Of the Fall and Spring Tests, we believe that the one containing lime 50 lbs., Sulphur 100, Water 50, to be the best.

RECOMMENDATIONS.

The question of whether to use a manufactured lime-sulphur solution, or make the concentrated solution himself, must be decided by the individual orchardist. There are so many details entering into the work that are governed by local conditions, that each grower must take up and decide independently. There is no doubt of the effectiveness of the home-made product when properly prepared. There is no doubt as to the economy of the problem. Up to this time the usual price of the manufactured product varies from 18 to 20 cents per gallon in small lots and 14 to 16 cents per gallon in barrel lots. The grower can make a similar product to cost him for materials about $2.25 to $2.50 per barrel, plus the expense of boiling, which is variable, but in no case should exceed 50 cents per barrel. Thus, a saving of about four dollars per barrel can be made by making the solution at home. While this would not amount to much in treating a small orchard, in treating anything over a thousand trees, the saving is considerable.

During the past season several responsible growers have undertaken to make the solution for the neighborhood, selling it much cheaper than the regular manufacturers. In such cases, it is probably best to purchase rather than go to the trouble and expense of fitting up a plant for one's self. The question of the price, of the solution and the inclination of the grower, again enters into the matter. It is quite certain that no grower should now bother with the old home-made lime sulphur wash, as the concentrated does the work and is much more convenient.

For those who may desire to make their own solution, the following formula and method of preparation is considered the best:

HOME-MADE CONCENTRATED SOLUTION.

Best stone lime....................................	50 lbs.
Sulphur (any kind finely ground, 98 per cent. pure).....	100 lbs.
Water	50 gal.

DIRECTIONS:

Heat about twenty gallons of water in an iron vat or by steam in barrels to near boiling, and add stone lime and sulphur gradually to prevent boiling over. Vigorous action will take place and cold water should be near at hand to be added gradually, to make a total of about 55 gallons. The solution should boil vigorously for one hour. It is then ready to be stored or to be diluted and used at once. In storing the solution it is necessary to exclude air from it as much as possible. by either filling up the barrel or other container completely with the liquid, or by putting a film of oil on the surface of the solution. The stored solution should be protected from extreme cold weather.

DILUTION OF THE MIXTURE.

In recommending the preparation of the concentrated lime sulphur by growers of this State last year, it was deemed best to advise employing the hydrometer test in seeking the proper dilution. By this test the growers could determine the proper strength to use the solution in comparison with the old home-made wash. In the light of the past year's experience, however, we deem the testing of the solution, if made by the above formula, unnecessary, and recommend that the solution be uniformly diluted at the rate of one gallon of the solution to six and one-half or seven gallons of water. The average density secured in these tests was about 29, which would require the dilution at the rate of one to 6¾. It is not to be inferred that it would not be desirable to test each barrel of concentrated, but we do not consider it necessary and therefore believe for all practical purposes the grower can depend on the quality of the solution, if good lime is used, and the directions for mixing are followed closely.

For those who wish to use the hydrometer the following directions and table are given, which indicates the proper dilutions for the different densities.

THE HYDROMETER.

As previously mentioned, in order to dilute the concentrated solutions in accordance with their density, they should be tested with a hydrometer. While this test will not reveal impurities, it will serve to indicate the strength of a regularly prepared mixture.

The Hydrometer is a glass instrument, something like a thermometer in shape. In testing a liquid the hydrometer is placed in it bulb down, and the reading is made at the surface of the liquid in which it is supported. The instruments are made in two scales, the specific gravity and the Beaumé. Both may be placed on the same instrument. Readings on the Beaumé scale are given in degrees, while the reading on the specific gravity is given in decimals.

The Beaumé scale is easier to read and, while more difficult to estimate from, in this case will serve with the aid of the tables given below.

Hydrometers can be secured for about $1.25 from Arthur H. Thomas, of Philadelphia, Pennsylvania; Eimer & Amend, of New York City, and other dealers in such apparatus. In securing an instrument the range on Beaumé scale should be 0° to 36° and 1.000 to 1.35 on the specific gravity.

TABLE FOR DILUTING CONCENTRATED SOLUTIONS.

Density Beaumé Scale.	Density Specific Gravity Scale.	For San Jose Scale Dilute With Water at These Rates.
35	1.3181	1 to 9
34	1.3063	1 to 8½
33	1.2946	1 to 8
32	1.2831	1 to 7¾
31	1.2719	1 to 7½
30	1.2608	1 to 7¾
29	1.2500	1 to 6¾
28	1.2393	1 to 6½
27	1.2288	1 to 6
26	1.2184	1 to 5¾

Period for Treatment.

While the most of the spraying for San Jose Scale in this State is done in the Spring, from observations and experiments, little, if any, difference can be noted in the effectiveness of the work whether done in the Fall or Spring. In cases where there is a great amount of spraying to be done, it is well to do a part of it in the late Fall, as Spring weather conditions often allow but a short period for spraying. From the results of some work conducted by the Department regarding the control of Peach Leaf Curl, it is believed that cases where the lime sulphur has failed to control the disease, to an appreciable extent, are due to too late spraying in the Spring. We believe that varieties, especially liable to attack from this disease, should be sprayed as early in the Spring as possible.

SPRAYING TESTS FOR TERRAPIN SCALE.

The extensive spread of this scale insect during 1910 in different sections of the State, led us to inaugurate a series of tests to determine the best remedy that could be used to control it, and which at the same time would be least injurious to the buds. As it was quite certain that the lime-sulphur solution was of little use in controlling it, the various miscible oils had to be employed. Three badly infested orchards were selected for the work,—two in Kent County and one in Anne Arundel. Both Fall and Spring applications were made at each place.

Tests in Kent County.

The following solutions were applied each on five trees in the Harris and Crewe orchards, November 12th and 13th, 1910:

Vacuum Oil, sold by Standard Oil Company, Baltimore; Soluble Oil, sold by Thomsen Chemical Company, Baltimore; San-U-Zay, sold by F. G. Street & Company, Rochester, N. Y.; Scalecide, sold by B. G. Pratt & Co., New York; Spray Oil, sold by Standard Oil Company; Lime and Sulphur, sold by Thomsen Chemical Company; Spray-On, sold by Robert H. Hutchinson, No. 530 W. 143rd street, New York; One for All, sold by Robert H. Hutchinson; Scale Oil, sold by Chester County Chemical Company.

A duplicate series was applied on like infested trees May 24th and 25th, 1911. On account of peculiar conditions developing in these orchards, no results of the work can be properly considered. A late frost together with unfavorable condition of the trees, probably due to drought in Fall of 1910, caused practically no fruit to set. In early April it was found that very few buds were alive, there being no difference between the sprayed and unsprayed trees. This condition then eliminated our hopes of learning the effects of the different miscible oils on peach buds. Later on, in considering the effect on the scale, it was found that both orchards were literally over-run with natural parasites, so that at the last examination practically no live scale could be found in the orchards consisting of five thousand trees. It was consequently impossible to intelligently determine the effectiveness of any of the solutions or draw any comparison between them.

This was a striking illustration of the ability of natural parasites to clean up an infestation of this scale insect. In view of these conditions, the results of both Fall and Spring work in Kent County orchards cannot be considered.

Tests in Anne Arundel County.

Fortunately for the work, natural enemies did not appear in the "Chaney" orchard to an extent sufficient to affect the results, although the most prominent parasite "Coccophagus lecanii Fitch" was bred from specimens taken from the orchard.

In this orchard ten different solutions were sprayed on about 350 trees.

The table on the opposite page gives a synopsis of the work:

It is seen from this that most of the miscible oils proved very efficient in controlling the Terrapin Scale.

On account of severe winter killing of twigs in this orchard, no definite conclusions concerning the effect of the solutions on the buds and trees can be drawn.

No explanation can be given for the failure of San-U-Zay and One-For-All. Difficulty was experienced in mixing both of the solutions.

TABLE III—*Showing the results of Spraying with different solutions for Leaf Curl and Terrapin Scale.*

SOLUTION	Date of Application	Dilution	Remarks on Miscibility	Number of Trees Sprayed	Control of Leaf Curl	Control of Scale
Vacuum Oil	11/23-24/11	1-15	Good	3	Unsuccessful	Successful
San-U-Zay........	11/23-24/11	1-15	Very poor soda used	3	Unsuccessful	Successful
Soluble Oil	11/23-24/11	1-20	Excellent	3	Unsuccessful	Successful
Soluble Oil	11/23-24/11	1-15	Excellent	3	Unsuccessful	Successful
Spray Oil.........	11/23-24/11	1-15	Good	3	Unsuccessful	Successful
One For All......	11/23-24/11	No. 1-1 gal.	Poor	2	Unsuccessful	Successful
Lime Sulphur.....	2/27/11	1-9	Excellent	10	Successful	Unsuccessful
Vacuum Oil.......	3/24-25/11	1-15	Good	22	Unsuccessful	Successful
Spray Oil.........	3/24-25/11	1-15	Good	30	Unsuccessful	Successful
Scale Oil..........	3/24-25/11	1-15	Good	30	Unsuccessful	Only partially successful
Spray On.........	3/24-25/11	1-15	Poor	28	Unsuccessful	Successful
Carbolineum.... Avenarius......	3/24-25/11	1-15	Excellent	29	Unsuccessful	Successful
Lime Sulphur.....	3/24-25/11	1-9	Excellent	29	Successful	Unsuccessful
Scalecide.........	3/24-25/11	1-15	Excellent	27	Successful	Unsuccessful
Protecto	3/24-25/11	1-15	Poor	30	Unsuccessful	Unsuccessful
San-U-Zay	3/24-25/11	1-15	Very Poor	22	Unsuccessful	Unsuccessful
One For All	3/24-25/11	No. 1-1 gal.	Poor	27	Unsuccessful	Unsuccessful
Checks...........	3/24-25/11	....	....	13	Unsuccessful	Unsuccessful

In considering the curl where any of the disease appeared the solution is considered unsuccessful.

RECOMMENDATIONS.

From these results, last year's tests and other observations throughout the State, it is believed that a standard miscible oil applied just before the buds open in the Spring, is the best treatment for the Terrapin Scale. The solution should be diluted at the rate of one part to fifteen parts of water. Treatment applied as late in the Spring as possible before the buds open is less likely to prove injurious to buds or twigs. There is no doubt that treating peach trees with any of the oil sprays may at any time be attended by injury, either to buds or twigs, or both. Nevertheless, this is the only treatment that seems available, and even if some injury to the tree is occasioned, it is better to run the risk than allow the Terrapin Scale to continue to develop in the orchard.

In cases of slight infestation, where only a few trees are affected, it is best to seek out all such trees and treat them with a miscible oil. As it seems advisable to treat all peach orchards with lime sulphur solution for the control of Peach Leaf Curl, as well as San Jose Scale, Fall treatment with the lime sulphur should be practised, followed by oil treatment late in the Spring.

Where Terrapin Scale is also present, the fact that natural parasites have done much good work in controlling it in many infested orchards in the State this year, does not insure relief from injury from this pest in the future. In fact, there are many infested orchards where they have not appeared in sufficient numbers to hold the pest in check. It may be said that the principal chalcidoid parasite,—Coccophagus lecanii, Fitch, was bred from Scale taken from various orchards in different parts of the State, showing that this parasite is generally distributed, although not abundant enough in most cases to eradicate the scale, as was the case in the Harris orchard.

In concluding the discussion of this insect we urge all growers to keep a watch on their peach trees to see that the pest does not gain a foothold. Its ability to cause severe losses principally by discoloring the fruit with the black fungus that thrives on its excretions, has been observed frequently in the State during the past two years.

GENERAL REMARKS.

After repeated discussions of methods of spraying and apparatus to be used in previous bulletins, some of which are now available, it is not thought necessary to discuss the subject at length here. It may be reiterated that success of any treatment will depend upon the thoroughness of the work. Good spraying cannot be done unless you have good apparatus in the form of pump, nozzles, hose, etc. Where there is much spraying to be done, a good power sprayer should be secured. Small orchards can be treated with double acting or barrel pumps. Anyone desiring specific information concerning the matter should communicate with the Station.

PUBLIC SPRAYING DEMONSTRATIONS.

Believing that one of the best means of disseminating information is by holding public meetings in the orchard at a time when any particular work should be done, this phase of our work has been extended as far as funds would permit, during the past year. In all, twenty-six spraying demonstrations for San Jose Scale and Codling Moth were held in different parts of the State. At such meetings, explanations are made by a member of the Department concerning the life history and control of many of our common insect pests, as well as the proper equipment and method of spraying.

The results of these meetings have been very gratifying, as they were well attended, and much interest manifested by the growers in the practical operation of spray rigs and application of remedies.

Not only is the grower able to see the treatment applied, but throughout the year the orchard in which the demonstration was conducted will serve as an example of up-to-date orchard practice to the people of the community.

All persons thinking that such work is especially needed in their localities, should communicate with the State Entomologist, at College Park, Maryland.

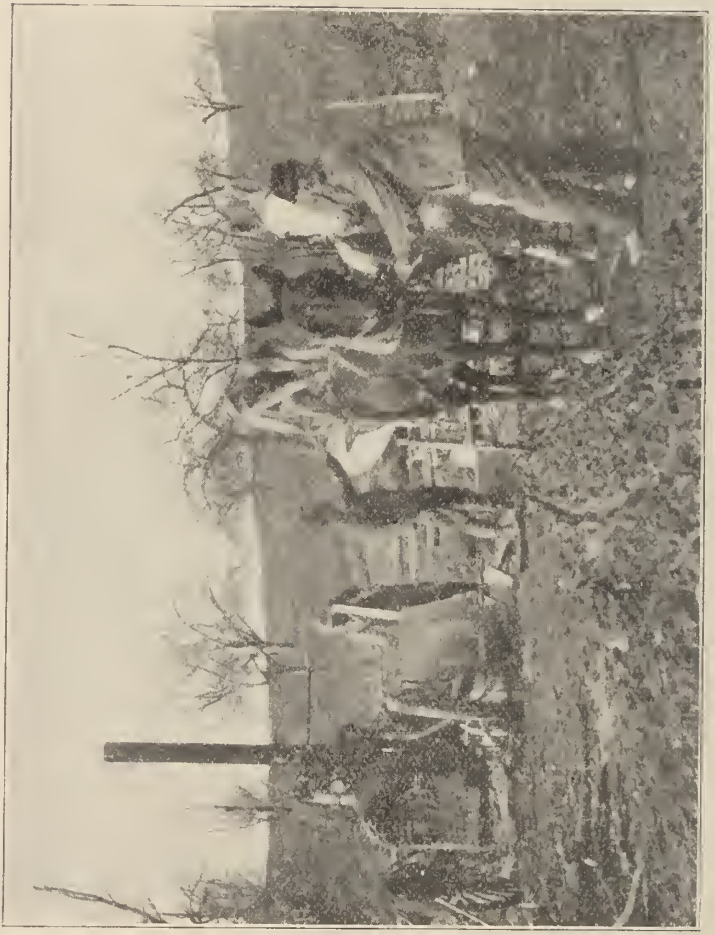


Fig. 1.—Outfit for experimental work at Harper's Ferry.

Fig. 2.—A demonstration spraying for San Jose Scale.

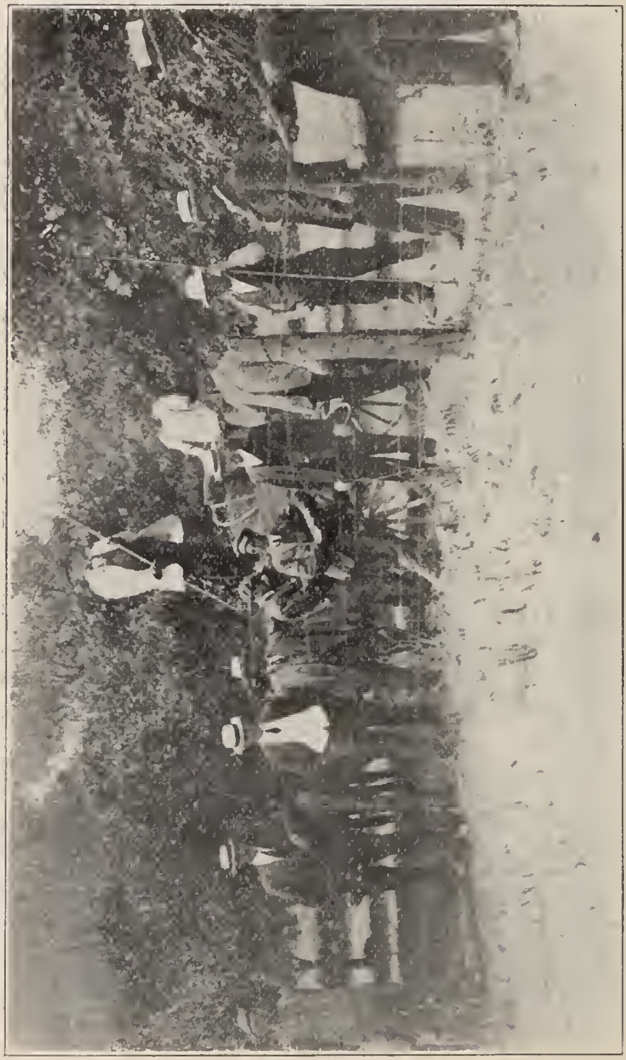


Fig. 3.—A demonstration spraying for Codling Moth.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 162. DECEMBER, 1911.

RESULTS OF SEED ANALYSES.

By J. B. S. Norton.

There is scarcely any phase of agriculture of greater importance than the seed question and none in which slighter differences produce greater results. Two kinds of seeds may be indistinguishable by every test and the one yield a crop of great value and the other be sown with loss of a season's labor and land rent. A little investigation of the great losses annually from poor seed will justify the most vigorous efforts to prevent them, for also, a little effort and expense to secure the best seed will be followed by good results far out of proportion to the cost.

Systematized seed control has been in operation in Europe for a long time and in recent years several states have adopted laws for the purpose of preventing accidental or intentional fraud in the seed trade as well as to control the dumping of low grade seed upon the American market as a result of the rigid laws of foreign countries protecting their home trade against such. As there is no law of this kind in Maryland the only check here is the reputation of the dealers, competition in the trade and education of the seed-buying public.

In pursuance of the latter purpose and for the assistance of both farmers and dealers a limited number of samples have been analyzed annually at this Experiment Station; and in order to ascertain the value for farm purposes of seeds on the market in Maryland, a man with special training in seed analysis was engaged for a time during the past summer in making germination and purity tests of samples of seeds secured from various sources in the state: from farmers, wholesale and retail seed dealers, and from general stores that carry a small quantity of seeds. Some of the more important results are published in this bulletin.

Good seed should be (1) of the variety desired; (2) reasonably free from impurities, whether of inert matter or seeds of other things; (3) capable of germinating and growing well.

The first of these must in case of closely related varieties depend upon the reliability of the dealer and the grower who raised the seeds, though in many cases the different kinds are distinguishable and of course the crop grown from them is usually good evidence of the nature of the seed from which it sprang. Impurities other than very closely related seeds can be easily recognized, at least by expert inspection; and reliable germination tests will give a good knowledge of the third requirement.

Table I gives some U. S. Department of Agriculture standards republished from Bulletin 148, New Hampshire Experiment Station and will show what one should expect in purity and vitality of first class seeds.

TABLE I.

STANDARDS OF PURITY AND GERMINATION OF AGRICULTURAL SEEDS.

SEED	Purity %	Germination %	SEED	Purity %	Germin-ation %
Alfalfa	98	85—90	Melon	99	85—90
Asparagus	99	80—85	Millets	99	85—90
Barley	99	90—95	Mustard	99	90—95
Beans	99	90—95	Oats	99	90—95
Beets	99	*150	Okra	99	80—85
Blue grass, Canadian	90	45—50	Onion	99	80—85
Blue grass, Kentucky	90	45—50	Parsley	99	70—75
Buckwheat	99	90—95	Parsnip	95	70—75
Cabbage	99	90—95	Peas	99	93—98
Carrot	95	80—85	Pumpkins	99	85—90
Cauliflower	99	80—85	Radish	99	90—95
Celery	98	60—65	Rape	99	90—95
Clover, alsike	95	75—80	Redtop	95	75—80
Clover, crimson	98	85—90	Rye	99	90—95
Clover, red	98	85—90	Salsify	98	75—80
Clover, white	95	75—80	Sorghum	98	85—90
Corn, field or ensilage	99	90—95	Spinach	99	80—95
Corn, sweet	89	85—90	Squash	99	85—90
Cowpea	99	85—90	Timothy	98	85—90
Cucumber	99	85—90	Tomato	98	85—90
Eggplant	99	75—80	Turnip	99	90—95
Kafir corn	98	85—90	Tobacco	98	75—80
Lettuce	99	85—90	Wheat	99	90—95

It is well known that older seeds do not germinate as quickly as new seeds. Table II gives a comparison of the rapidity of germination of several samples of red clover seed, the height of the line from each number indicates the number of seeds, out of 100 germinable seeds, which sprouted on each day after the test was started. The Roman numerals opposite each line indicate the relative prices of the various samples, I being the higher priced clover, II the next, etc.

Table III gives the results of analyses made here this year. The letters in the first column represent persons or firms from whom the tested samples were obtained, the second column gives the number of samples from each, the third column the average of all the purity tests for each person or firm, the fourth the average of germination tests and the fifth column the average of the percentages of good, germinable seed in the samples. In the three columns under the different named

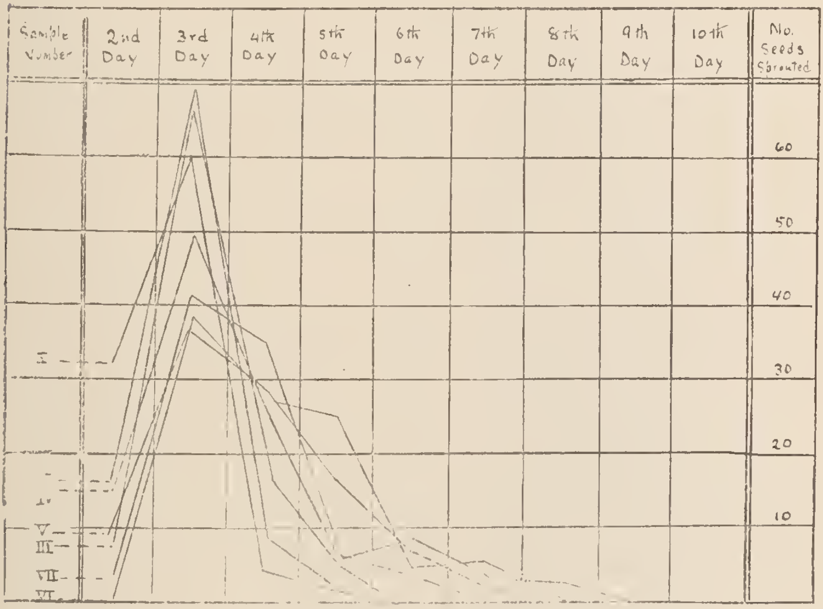
---

*Each beet fruit or "ball" is likely to contain from 2 to 7 seeds. One hundred balls should yield at least 150 sprouts.

kinds of seeds is given (1) the percentage of good seed in the best sample; (2) the average percentage of good seed and (3) the poorest; where only one sample was tested it is given in the second column. The fifth column might be used to compare the grade of seed offered by the different dealers but in most cases scarcely enough samples have been tested to make such a comparison very accurate.

Perhaps the majority of the vegetable and flower seeds used for home gardens are bought in small packages at the local stores where they are obtained from various seed houses making a business of such trade. Recent investigations by the U. S. Department of Agriculture of 2778 packets from 27 seed houses of this class showed an average of 62.2% vitality while the average for the different houses varied from 27.3% to 81.7%. The uniformly low vitality of the seeds from several of these seed supply houses indicates that they are doing a fraudulent business and with people least able to protect themselves. The average in germination of all these seeds was 25% lower than the general average of those sent out in the congressional seed distribution.

TABLE II.



Some idea of the condition of this character of flower and vegetable seeds can be gained from the few tests recorded opposite "F" and "H" in Table III. Probably thousands of packages of flower seeds of this kind are bought annually and sown with no results except discouragement of young or unskilled persons who would otherwise have gained an interest in horticulture.

TABLE III.

RESULTS OF SEED ANALYSES, 1910-11.

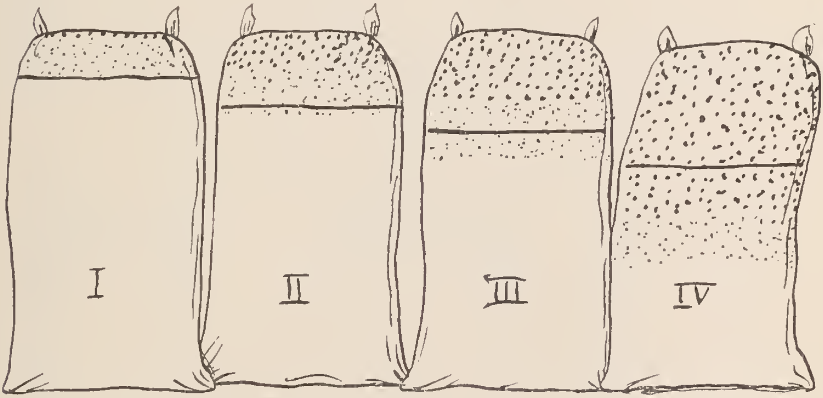
Source	No. Samples	Purity Av.	Vitality Av.	**Value Av.**	Red Clover			Alsike Clover			Crimson Clover			Timothy			Red Top			Alfalfa			Other Field Seeds			Vegetable Seeds			Flower Seeds		
					Best	Average	Poorest	Best	Average	Poorest	Best	Average	Poorest	Best	Average	Poorest	Best	Average	Poorest	Best	Average	Poorest	Best	Average	Poorest	Best	Average	Poorest	Best	Average	Poorest
A	31	93	84	**78**	93	82	65	92	72	34	90	88	86				98	71	50		74		92	79	52						
B	30	97	94	**91**	88	86	83	82	79	76	96	91	76	*99	*97	*95		*98		93	89	82	98	81	58						
C	7	99	86	**85**	97	94	92		79					93	85	77		66			88										
D	2	96	96	**89**																				*99			89				
E	1	99	99	**98**																	98										
F	8	99	31	**30**																						96	51	2	39	10	0
G	2	100	88	**88**																						88	88	88			
H	1	100	41	**41**																										41	
I	3	100	70	**70**																							70				
J	3	99	76	**75**	81	75	71																								
K	2	99	95	**94**	94	94	94																								
L	1	94	84	**79**		79																									
M	1	95	94	**89**		89																									
N	2	97	92	**89**								87									92										
O	1	99																			*99										
P	1	98	98	**96**																				96							
Q	2	94	86	**81**											69									93							
	No. Samples					18			12			10			7			5			9			22			10			5	

*—Purity test only. J to Q are from farmers.

The following diagrams in Tables IV, V, VI and VII will show graphically the character of clover seed sold in Maryland in 1910 and 1911, as well as the relation of price asked for different grades of clover seed to its actual value for seeding, and will indicate the false economy of buying low grade seed aside from the danger of introducing weed seeds.

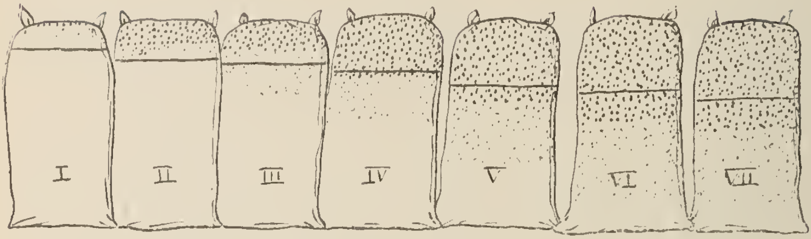
The better condition of the 1911 figures over the 1910 may be due to natural conditions in the seed crop, to better cleaning and grading methods or to recent agitation of the pure seed question. Recent work in other states shows that the seed laws and pure seed agitation have greatly improved the quality of seed on the market as well as increased the price of good seed. In Iowa 186 samples of alfalfa, timothy and 5 kinds of clover (104 samples of red clover) averaged over 98% of purity.

TABLE IV.



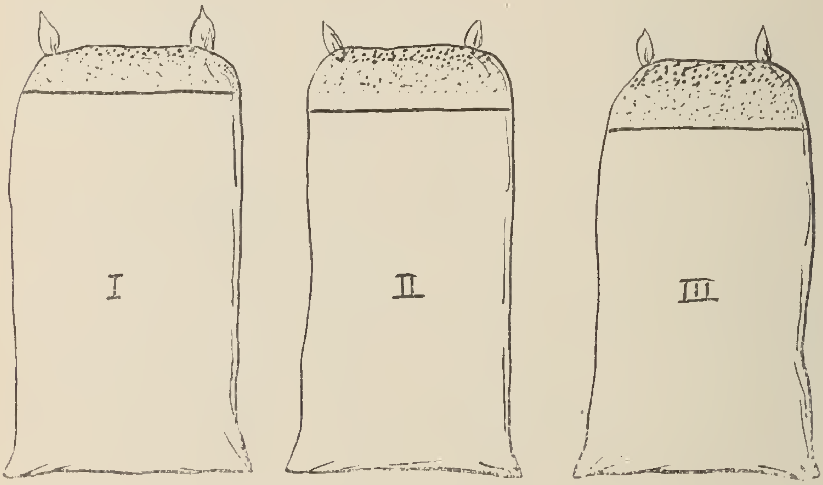
FOUR GRADES OF ALSIKE CLOVER SEED FROM ONE DEALER 1910. THE WHITE PORTION OF EACH SACK REPRESENTS GOOD SEED, THE HEAVILY DOTTED PORTION WEED SEED, AND THE LIGHTER DOTTED PART DEAD CLOVER SEEDS. THE PART BELOW THE HEAVY LINE REPRESENTS RELATIVE PRICES CHARGED. ASSUMING THAT THE WEEDS AND BAD SEED ARE DONATED IN THE BEST SAMPLES, IT WILL BE SEEN THAT IN THE POORER GRADES THE BUYER ONLY GETS PART OF THE WEED SEEDS FREE AND MUST PAY FULL PRICE FOR ALL THE USELESS CLOVER SEED.

TABLE V.



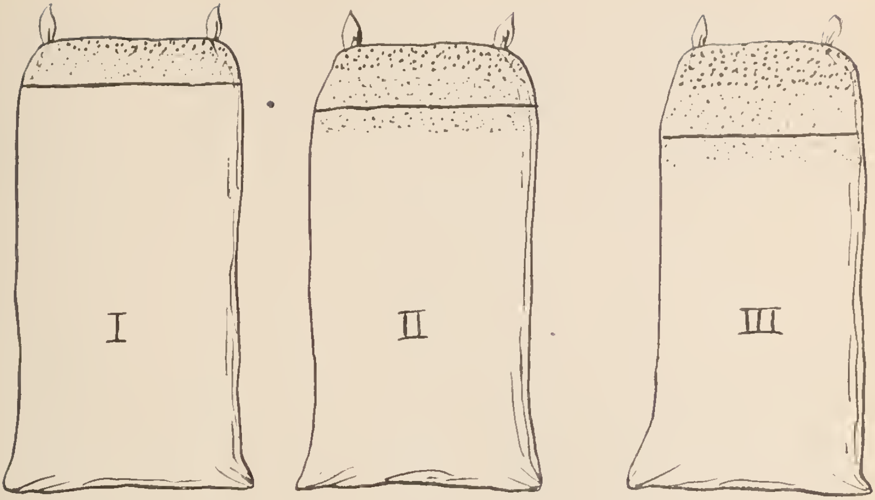
Seven samples of red clover seed from one dealer, 1910. The white portion of the sacks represents the percentage of good seed in each. The part shaded with large dots is the percent. of weed seeds and the small dotted part the dead clover seed. The part below the heavy line represents the relative prices asked, assuming that only the good seed is charged for in the best samples The second best sample has the cheapest good seed, while in the poorer grades one has to pay for the dead seed and even part of the weed seeds.

TABLE VI.



Three grades of red clover seed, 1911. The white portion of each sack represents good seeds, the part shaded with large dots is weed seeds, the small dots dead clover seed. The part below the heavy line represents the relative prices asked. I and II have the same amount of good seed so that II would be the cheaper if the weed seed are not considered. Perhaps the good seed above the price line is some equivalent for the weeds. The good seed in III are also sold at a less rate than in I.

TABLE VII.



Three grades of alsike clover, 1911. The white portion of each sack represents good seed, the part shaded with large dots weed seed, the small dots dead clover seed. The heavy line represents the relative prices charged.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN 163. JANUARY, 1912.

INCREASING THE DURABILITY OF FENCE POSTS.*

By F. W. Besley.

Introduction.

The local supply of durable woods for fence posts in many parts of Maryland has become exhausted, and to supply the increasing demand is a serious problem. Up to the present time red cedar, locust and chestnut have furnished the great bulk of fence posts, and are still our most desirable woods for the purpose. The growing scarcity of these woods, in many parts of the State, has necessitated the use of substitutes, with less satisfactory results. There is a considerable area of the State where red cedar does not grow in commercial quantities at all, and only sparingly in other sections. Besides, it is a slow-growing tree that is not suitable for planting to produce fence posts. Locust, another very durable wood, is only partially distributed, and in many places where it is abundant it is being badly damaged by the locust-borer, an insect that burrows through the wood, killing, or making worthless, the tree attacked. Chestnut, while less durable, is still a good fence post wood, but this tree also is seriously attacked in the northern and eastern sections of the State by a fungus disease that has killed a considerable per cent. of the trees in some sections, so that it cannot be depended upon to fully meet future needs. Necessity has, therefore, compelled farmers and other users of fence posts to try substitutes for the durable woods which cannot now be obtained in sufficient quantity to meet the demand. In using the less durable woods there is the same expense of preparing and setting the posts, and if they last only one-half or one-third as long there is the increased cost of frequent renewals. To meet this difficulty the only promising way is to take the inferior woods, which we must use, and treat them with a preservative that will greatly prolong their life. Experiments to test wood preservatives were begun at the Maryland Experiment Station twenty-three years ago, and are probably the first recorded experiments in regard to treating fence posts of which we have any record in this country. The idea of preserving fence posts by special treatment was little thought of in those days, when there was an abundance of timber. The value of preservatives used twenty years ago to prolong the life of farm timbers was little known, and many then employed have since been practically discontinued, while new ones have been discovered. Methods of applying preservatives have likewise undergone many changes. The rapid exhaustion of our timber supplies has greatly increased the interest in timber production, and much of it has centered in the question of fence posts and farm timbers. It is, therefore, of interest to recall these experiments started in 1888, and to point out some conclusions that may be drawn therefrom. In the latter part of this bulletin will be found a discussion of some recent experiments, undertaken with a view of determining the best preservative to use for certain woods, and the best method of applying the preservative.

---

*The tests recorded in the second part of this bulletin were conducted in cooperation with the United States Forest Service.

METHODS EMPLOYED IN THE PRESERVATIVE TREATMENT OF FENCE POSTS.

Early Experiments.

In May, 1888, two experimental fence lines were established on either side of the turnpike, adjacent to the Experiment Station buildings. Line *A*, on the east side of the turnpike, consisted of one hundred sound, seasoned red cedar posts, seven and one-half feet long, and averaging from four to five inches at the top end. Line *B*, west of the turnpike, contained likewise one hundred posts, but all the posts were green, sawed chestnut, seven and one-half feet long, and from five to six inches square. The one hundred posts in each line were treated in duplicate sets of ten, as follows:

The first ten were set in the usual manner, holes dug with a post-hole digger, or shovel, and no special preparation given either to the holes or to the posts.

The second ten were coated with coal-tar for about three feet, three inches from the base, including the bottoms.

The third ten had a ring or band of coal-tar, one foot wide, beginning at a point about two feet three inches from the base and extending upward.

The fourth ten were treated like the second, but using creosote oil instead of coal-tar.

The fifth ten were treated like the third, using creosote oil in place of coal-tar.

The sixth ten were treated like the second, but using crude petroleum instead of tar.

The seventh ten were treated like the third, using crude petroleum in place of tar.

The eighth ten had about three and one-half feet of the base coated with crude petroleum, and then charred, by burning off the oil.

The ninth ten were set in holes fifteen to eighteen inches in diameter; the posts had no special preparation, but the holes were filled with stones and brick-bats to within three inches of the surface, when soil was put on to finish filling the hole.

The tenth had, also, no preparation, but were set in holes of the same size as those for the ninth lot, and filled with the original soil, well tramped down.

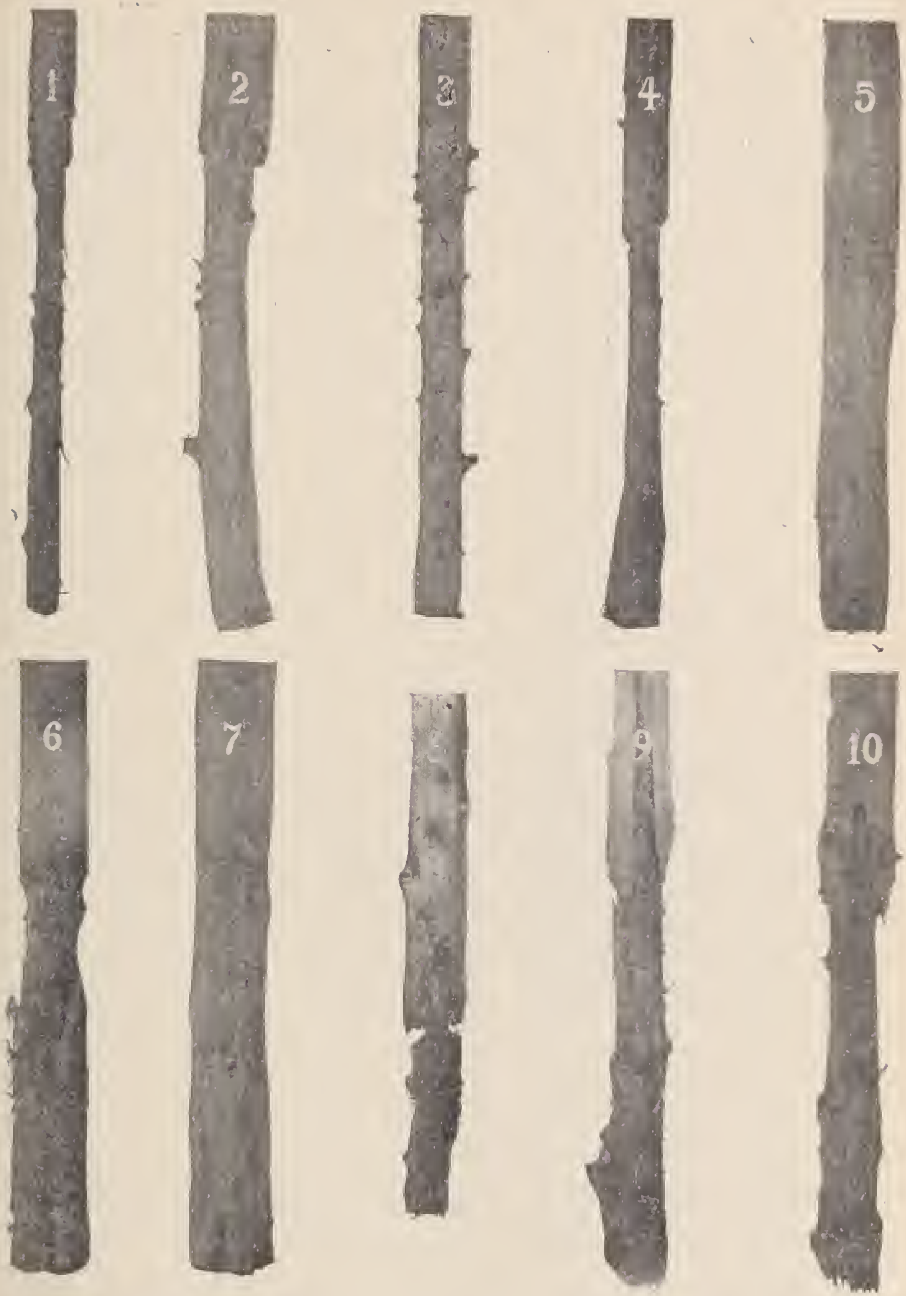


Plate I.

Treated and untreated seasoned cedar fence posts after twenty years service.

Only the base of the post is shown and each post is the one showing greatest decay in the set, corresponding to the number given. (See page 4.)

Both of these fence lines are located along a heavy clay flat, where drainage is poor, and where conditions are especially conducive to the early decay of the wood.

In the summer of 1908 the writer examined all the posts in Line A. The cedar posts had then been in service just twenty years, and showed the following conditions by groups, arranged according to serviceability, as follows:

TABLE I.

Showing condition of treated and untreated cedar posts, after twenty years' use, arranged according to comparative durability.

Group number.*	Per cent. solid.	Per cent. slightly loose.	Per cent. shaky.	Per cent. rotted off.
V	100	0	0	0
IV	90	10	0	0
VI	60	40	0	0
VII	80	10	10	0
III	60	30	10	0
II	40	50	10	0
I	40	50	10	0
IX	40	40	10	10
VIII	10	60	20	10
X	50	0	50	0

*See description of treatment by groups on page 4.

The column headed "solid" indicates the posts that had not decayed enough to cause the outer wood to sluff off and make the post loose.

The column headed "slightly loose" indicates the posts in which the outer wood had decayed and sluffed off, so that they did not stand firm in the ground.

In the column headed "shaky" are included the posts badly decayed, which had practically become unserviceable.

The column headed "rotted off" indicates the posts that had broken off near the ground.

Table I shows the relative durability of the sound, seasoned cedar posts, under the different methods of treatment.

The following conclusions may be drawn:

1—That applying a preservative with a brush is not very effective. (Compare sets I, IX and X, with others.)

2—That creosote oil is more efficient as a preservative than either coal tar or crude petroleum. (Compare sets IV and V with II, III, VI and VII.)

3—That charring the parts of the post which is to be placed underground does not add materially to its durability. (Compare set VIII, with others.)

4—That filling in around the post with stone or brickbats does not increase its durability.

While the records are not specific as to the manner of applying the preservative, it is believed that the application in each case was with a brush, and that the liquid was only heated enough to make the application easy. The application of a preservative, especially of the density of cold creosote, by means of a brush, would not give much penetration.

Since the depth of penetration, and absorption of the preservative, determines the effectiveness in retarding decay, it can be readily understood why these treatments were not more effective.

Creosote is today, after much experimentation, recognized as the best preservative for fence posts. Crude petroleum seems to be more effective than coal tar. This is probably due to the greater penetration of the former, giving a greater protection to the wood.

Charring the lower portions of the posts to increase their durability is shown by these experiments to have no value. The only value it could have, in any case, would be to hasten the seasoning process, and possibly sterilize the wood, and to that extent only would it increase the length of life of the posts, for it is a well-established fact that well-seasoned posts of any kind of wood will last longer than those only partially seasoned. The posts used in the experiment were of seasoned wood, and hence no increase in durability could be expected by charring.

The green sawed chestnut, in Line B, were dug up and examined in the early winter of 1908. It was found that only a few of these posts remained; the others had rotted off, and had been replaced from time to time, so that the value of the experiment was largely nullified by lack of data for the previous ten or fifteen years, when most of the posts were replaced. However, as oak and cedar posts were used, when replacing was necessary, and assuming that all replaced posts had become unserviceable (which is reasonably certain) the results obtained, are of value as showing which of the methods of treatment employed, were most effective. The results obtained are given in the following table:

The life of a sound, green chestnut post is usually not more than eight years, but in these experiments, the posts were unusually large, and consisted almost entirely of heartwood, so that a greater length of life might be expected. Table II shows that the application of either creosote, coal tar or petroleum, with a brush, will prolong the life of green chestnut posts, and that the relative effectiveness of the preservative is in the order given. The fact that group VIII, in which the posts were charred, shows 10 per cent. of serviceability after twenty years, indicates that charring in the case of green posts may be beneficial. As previously pointed out, the increased life is probably due to the partial seasoning and sterilizing, resulting from charring, and not to the formation of charred wood.

TABLE II.

Showing condition of treated and untreated green chestnut posts after twenty years, arranged according to relative durability. Only chestnut considered (others as replaced posts).

Group number.*	Per cent. serviceable.	Per cent. unserviceable.	Per cent. rotted off or replaced.
IV	30	30	40
II	20	20	60
VI	0	20	80
V	10	0	90
VIII	10	0	90
III	0	10	90
I	0	10	90
VII	0	0	100
IX	0	0	100
X	0	0	100

*See description of treatment by groups on page 4.

WHY WOOD DECAYS.

The decay of wood is due to minute vegetable organisms known as fungi. These low forms of vegetable life have fruiting bodies which appear as punk on rotten wood, or as small pustules which appear on the surface, but which are not always readily observed. The fruiting bodies send out minute spores by the thousands, which are wafted by the wind or carried on the bodies of insects, birds, animals, etc., and whenever they are deposited on a piece of wood, under favorable conditions, they germinate, sending little threads into the wood substance. These threads, or hyphae, as they are called, have the power of breaking down the cellular structure of the wood, causing its decay. From this decayed wood the fruiting bodies appear on the surface, and a new generation of spores is liberated to continue the life history of the fungus.

A fungus cannot live without a supply of organic food, moisture, warmth and oxygen. These are the conditions necessary for the development of the fungus. It is true that some of the organisms can live with a much smaller amount of one or another of the elements, but all are essential in some amount at least. Wood being an organic substance, there is abundant food for the fungus to live upon. The wood of a fence post set in place is moist, there is in summer abundant warmth, and there is also an abundance of atmospheric oxygen to keep the fungus alive, even for some distance down in the soil; thus all of the conditions are present, favorable to rapid decay. The question is, how can at least one of these essential elements be controlled to the extent of excluding fungus life? By means of thorough seasoning of the wood before the post is set, decay can be retarded, but not prevented. The supply of warmth and oxygen cannot be controlled. Practical experiments have shown that the only feasible way of effectively preserving wood, is by the application of a substance which is poisonous to fungi, and as long as there is an unbroken film of the preservative on the surface of the post, no fungi can enter. But just as soon as this film is broken by the checking of the wood, or the leaching out of the poison, the wood is subject to decay. This has led to much experimentation, but for fence posts creosote has proven the best preserving substance to use. It is no more poisonous to fungi than other substances, some of which are cheaper, but its chief merit lies in its greater insolubility in water, making it more permanent than the others, especially when the wood is to be placed in moist situations, such as is the case with fence posts, where the leaching process is constantly in progress.

NEW EXPERIMENTS.

Purpose of the Experiments.—A new line of experiments with fence posts was undertaken by the Experiment Station, in co-operation with the Forest Service, United States Department of Agriculture, in the spring of 1909. The Experiment Station furnished about 1,000 posts, and the necessary labor for handling them, while the Forest Service supplied the apparatus and preservative materials used.

The experiments were designed particularly to show the most economical methods of treatment in the light of present attainments in wood preservation. It has been found that the application of creosote to fence posts gives the best results, the questions to determine being the amount that should be used, the most practical method of applying it to posts, and the relative value of the different kinds of wood, for the purpose of treatment. In time, the increased durability, due to the specific treatment given, as compared with untreated posts set at the same time, will be shown.

Other important facts brought out by the experiments were the rate of seasoning, the cost of treatment (using different methods) the possibility of reducing cost by the substitution of other materials than creosote for part of the process, etc.

In the experiments 977 posts were used. These were all round (except twenty split locust) peeled and beveled at the top by a slanting cut. The sizes varied considerably, ranging from 2½ to 7 inches top diameter, and all were cut 7 feet long. Nineteen different kinds of native woods were used, distributed as follows:

Beech 51, River birch 50, Chestnut 50, Black gum 49, Sweet gum 51, Red cedar 48, Locust 69, Red maple 50, Chestnut oak 50, Pin oak 50, Red oak 51, White oak 52, Spruce pine 101, Silver poplar 51, Sassafras 1, Sycamore 50, Yellow poplar 51, Black willow 63, White willow 40; total 977.

SEASONING.

It has been fully demonstrated that thorough seasoning is the first important step in preparing fence posts for use. When the posts are to be treated with a preservative they should always be thoroughly seasoned before treatment. This is absolutely necessary in order to permit a proper penetration of the preservative. Seasoning tests were made with fifteen of the species used in subsequent experiments, in order to determine the length of time required to secure a satisfactory seasoning to insure thorough treatment. These posts were cut between April 9 and 19, and peeled about two weeks after cutting. During the two weeks before peeling, the posts were in close piles, and lost so little in weight that seasoning may be counted only from the time the posts were peeled: These posts were weighed at that time and carefully piled in open piles in alternate tiers of three and seven, placing fifty in each pile. This arrangement insures full circulation of air. (See plate 1). Twenty posts of each species were weighed each week thereafter for thirteen weeks to note the loss in weight, due to evaporation of moisture, which constitutes the seasoning. In nearly every case the loss in weight the first week was very rapid (chestnut oak and pin oak were the only exceptions), and after that, the loss from week to week became more uniform. The greatest loss per cubic foot* was in the case of yellow poplar, which was 14.3 pounds, and the smallest was that of pin oak and chestnut oak, each .2 of a pound per cubic foot. In Table III is given the weight per cubic foot of each species of wood at the time of peeling, the length of time required to secure a satisfactory seasoning for treatment, and the weight per cubic foot at that time.

TABLE III.

Species.	Weight (green) per cu. ft.	Number of weeks required to season.	Weight seasoned per cu. ft.
Pin Oak	64.1	6	53.4
Red Oak	63.7	4	56.9
White Oak	63.0	4	56.9
Red Birch	61.6	5	44.2
Sycamore	60.0	4	42.4
Black Gum	59.8	7	42.6
Chestnut Oak	59.3	5	54.9
Sweet Gum	58.0	4	43.5
Beech	57.0	4	44.6
Red Maple	54.8	5	41.0
Chestnut	54.7	3	48.5
Yellow Poplar	54.0	8	29.1
Spruce Pine	51.8	3	38.0
Willow	50.4	8	31.7
Silver Poplar	42.6	5	32.1

---

*Since the posts varied in size, the bulk of each was reduced to a cubic foot basis, in order to make comparison. It may be said that a post seven feet long, with a middle diameter of 5.1 inches contains one cubic foot. Ordinarily a post four to four and one-half inches, at the top, is equivalent to one cubic foot.

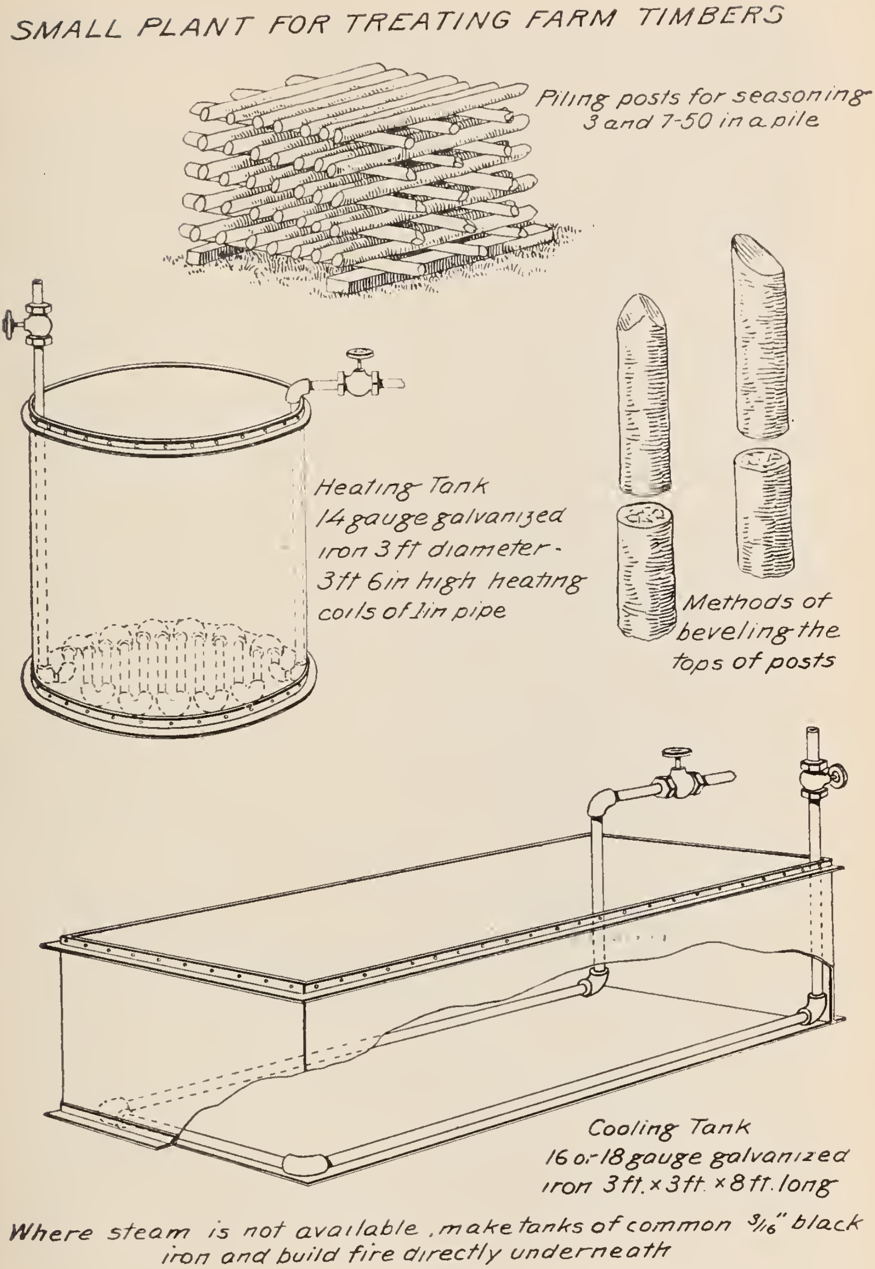

SMALL PLANT FOR TREATING FARM TIMBERS
Piling posts for seasoning 3 and 7-50 in a pile
Heating Tank 14 gauge galvanized iron 3 ft diameter - 3 ft 6 in high heating coils of 1 in pipe
Methods of beveling the tops of posts
Cooling Tank 16 or 18 gauge galvanized iron 3 ft. × 3 ft. × 8 ft. long
Where steam is not available, make tanks of common 3/16" black iron and build fire directly underneath

Plate II.

This illustrates the outfit for treating posts and the method of piling, and beveling the posts used in the Experiment Station tests in 1909.

During the seasoning period the weather conditions were normal, but to apply these figures to other climatic conditions would require some modification, although in themselves they show the relative rates of seasoning for the different woods.

Posts cut when "the sap is up" peel much more readily than those cut during the dormant season. If, therefore, posts intended for treatment are cut soon after the buds have begun to swell, they can be readily peeled, and will have plenty of time in which to season, preparatory to treatment in the latter part of summer, and can be set in the fall.

Round posts are preferable to split posts, for it is the sapwood which is penetrated by the preservative most readily, and in all preservative treatments a thorough penetration is essential to insure success.

THE TWO-TANK METHOD OF TREATING FENCE POSTS.

The posts are first subjected to a heating process in a tank containing creosote or other heating medium, the object being to heat the wood cells sufficiently to expand the air and water which they contain, so that most of it will escape in bubbles that rise to the surface of the oil during the heating process. Only the lower portions of the posts are immersed in the hot bath, because that is the part subject to decay. After the posts have been suspended in the hot bath long enough (see page 15) they are quickly transferred to the cold bath of creosote, contained in a tank of sufficient size to immerse the entire length of the posts. The result is that as the wood cools in the cold bath of creosote, the air in the wood cells condenses, forming a partial vacuum which causes the oil to be sucked in, thus replacing the air and water lost during the heating process. Since only the lower part of the post was heated, this part received a much deeper penetration of the preservative when the entire post was immersed in the cold bath. The penetration in each part, however, is in just about the right proportion to secure the greatest service with a minimum quantity of preservative.

The two tanks used in the experiments are illustrated in plate III.

The heating tank was cylindrical, three feet in diameter and four feet high. The bottom of the tank was covered with a coil of one-inch galvanized iron pipe. This coil was connected with a steam boiler to produce the proper degree of heat (about 220° F). A framework of boards on top of the coil, protected the pipe from injury, when the posts were dropped in. The posts were submerged in the liquid for a depth of two and one-half feet. In a tank of this size about twenty-five posts can be treated at one time. The tank should be sunk in the ground about eighteen inches for ease in placing and removing the posts.

The cold bath tank was rectangular, eight feet long, three feet wide and three feet deep, reinforced by a frame work of two by four inch material. The posts are transferred from the hot bath and laid horizontally. They are held under the liquid by means of a frame cover held down with a lever. (See plate II.)

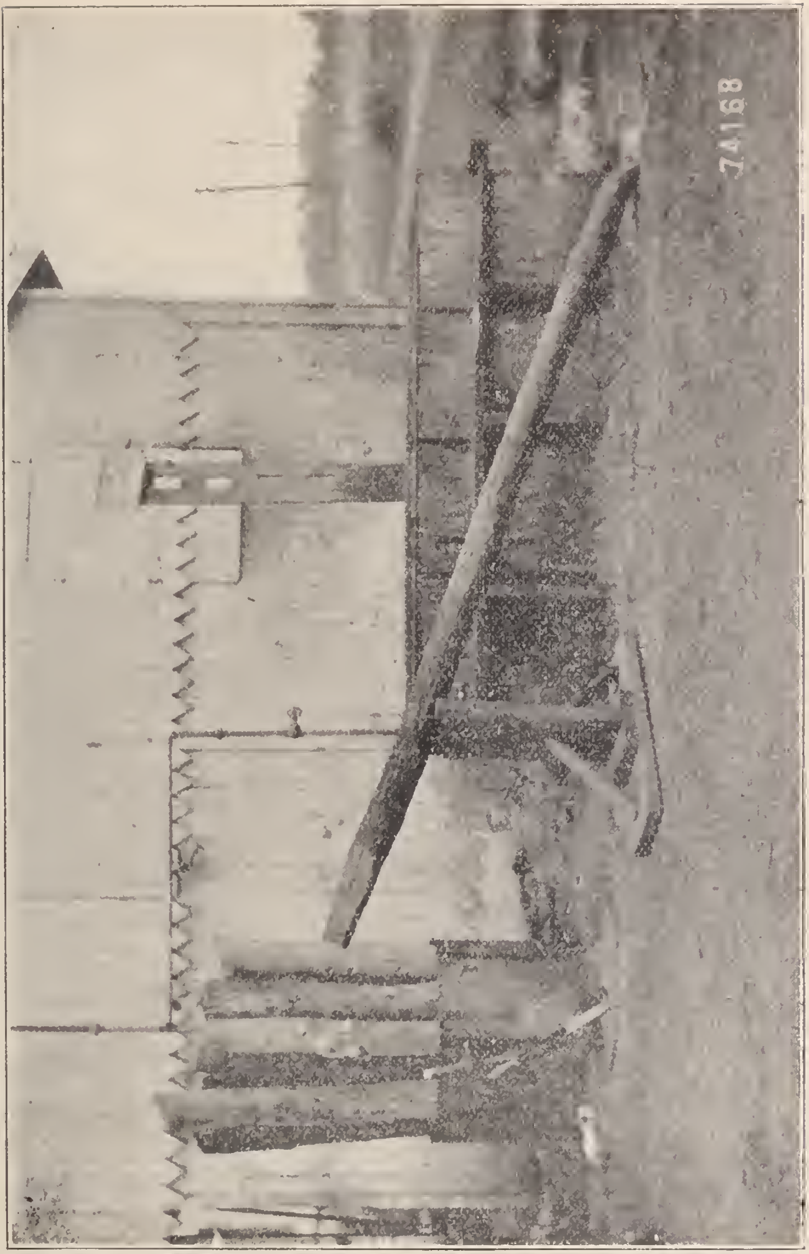


Plate III.

View showing the hot bath (on the left) with base of posts in the hot creosote. The cold bath tank is shown on the right and a device for keeping the posts submerged in the cold bath is shown in the foreground. The square end of the lever fits into the hole of the upright, which extends above the back side of the cold bath tank.

The apparatus used in these experiments, and described above, costs about $50, and is a good one to use when a large number of posts are to be treated. It is portable, and about such an outfit as would be suitable for a number of farmers, who might wish to club together for the purpose of providing a cheap, but rapid, method of treating fence posts, shingles, or other small timbers.

For the man who wants to treat but a few posts, good results can be obtained by a much simpler apparatus, such as a large iron pot or old boiler heated by fire underneath. The fire pot should be enclosed, or nearly enclosed, by a masonry wall to confine the heat under the tank. If nothing is available for a cold bath tank, the cold bath may be given the posts by allowing them to remain in the heating tank with the fire drawn, so that the oil may be allowed to cool. The tops may be given a light treatment by inverting the posts, and allowing them to remain in the cold oil for a short time.

THE BEST TREATMENT FOR EACH SPECIES OF WOOD.

The fact that any wood properly impregnated with creosote will not decay, so long as the protective cover of creosote remains, makes it possible to use very cheap woods for fence posts, if properly treated, because such treatment insures long service for the post. In this way many of our least durable woods, easy to obtain, may be satisfactorily substituted for the woods that are naturally durable, but difficult to obtain. It is very important to know just how much creosote must be injected into any specific wood to secure a satisfactory impregnation, and at the same time not to use more than may be necessary, which would be a waste of material and add to the cost. The object is to get the deepest penetration possible with a limited absorption of preservative. To determine the length of time that each kind of wood should remain in the hot and the cold bath, to get the proper penetration, with the minimum amount of preservative, and hence the lowest cost, about ten sets of posts of each species of wood were tested, each with a different time allotment in the hot and in the cold bath. A sufficient penetration is secured in the case of species having a narrow sapwood when all of the sapwood in the lower part of the post is impregnated. When the sapwood is more than one inch thick, a one inch penetration of the butt is considered sufficient. An absorption of five pounds of creosote per cubic foot of post is the standard to be attained. On this basis the most satisfactory treatment for each kind of wood tested in the experiments, with particular reference to the time to be allowed for the hot bath, and the time allowed for the cold bath is as follows:

COST OF TREATMENT.

With creosote at 15 cents per gallon, and making an allowance of 20 per cent. of the amount used as the loss in volatilization, the cost of creosote for treating each post according to the directions given in table IV is as follows:

TABLE IV.

			Penetration		
Species.	Hours in Hot Bath.	Hours in Cold Bath.	Butt Inches.	Top Inches.	Pounds Per cu. ft.
Beech	1	¾	1.0	0.4	5
Red Birch	4	1	1.0	0.3	6
Chestnut	4	2	0.2	0.1	2
Black Gum	2	¾	0.8	0.3	5
Sweet Gum	1	1	1.5	0.3	5
Red Cedar	6	3	0.4	0.2	1½
Locust	4	1	0.2	0.0	1
Red Maple	4	2	1.0	0.3	5
Chestnut Oak	1	¾	0.5	0.3	3
Pin Oak	1	¾	1.0	0.5	4
Red Oak	1	¾	0.5	0.3	3
White Oak	1	¾	0.5	0.3	3
Spruce Pine	3	2	1.0	0.4	4
Silver Poplar	6	4	1.0	0.2	4½
Sycamore	1	½	1.0	0.2	5
Yl'w Poplar	3	1	1.0	0.2	7
Willow	4	1	0.6	0.2	5½

TABLE V.

Species.	Cost of Oil per Post.
Beech	$0.106
Birch	.127
Chestnut	.042
Black Gum	.106
Sweet Gum	.106
Red Juniper	.032
Locust	.021
Red Maple	.106
Chestnut Oak	.064
Pin Oak	.085
Red Oak	.064
White Oak	.064
Scrub Pine	.085
White Poplar	.095
Sycamore	.106
Tulip-Tree	.148
Willow	.116

It is assumed in the above table that each post contains one cubic foot, that is, seven feet long with an average diameter of 5 inches, which is about the average size.

The average cost of treating posts of the different species with creosote, as recommended, was a little over eight cents each. As long as there is an unbroken band of creosoted wood around the post it will not decay, no matter what kind of wood it is. Furthermore, it has been found that woods that have heretofore been regarded as unsuited for fence posts, because of their rapid decay, are generally easily impregnated with creosote, and made as durable, or more so, than untreated woods which have the longest natural durability. The farmer who cannot readily secure red cedar, locust or chestnut for posts need have no hesitation in using the so-called inferior woods, provided he can properly treat them. Taking a number of these common woods, their adaptability for treatment has been worked out, showing their rank as follows, the best first:

Spruce pine, Sweet gum, Beech, Pin oak, Red maple, Sycamore, Red birch, Yellow poplar, Red oak, Black gum and Willow.

Since the sapwood is much easier to treat than the heartwood, all parts intended for treatment should be round. Of the nineteen species used in the treating experiments, beech and sycamore were the only woods in which the heartwood could be satisfactorily treated and, therefore, the only ones where split posts were as satisfactory as round ones for treatment.

In treating the different woods, certain peculiarities were discovered which influenced greatly the effectiveness of the treatment, and are here given to guide those who may undertake the treating of fence posts.

Spruce pine, because of its cheapness, good form and lightness, is excellent for fence posts when it can be treated, which is easily done. Any of the native pines in the State are almost equally as good. The difficulty is that the thin inner bark, which adheres very closely, prevents a proper penetration of the creosote. This can be easily overcome by careful peeling, especially for at least six inches above and six inches below what will be the ground line when the post is set in place. It is this section of the post that is subject to the most rapid decay.

Sweet gum is very easy to treat, and because of its abundance throughout the Eastern Shore section, where durable woods are scarce, it should be generally used, when treated. The sapwood is wide, permitting a penetration sufficiently deep to be thoroughly effective.

Beech is one of the easiest woods to treat, and since the heartwood is almost as easily treated as the sapwood, it makes little difference whether the post is round or split. It is not an abundant wood, except in a few sections, but because of its general distribution and cheapness, it is well worthy of consideration.

Pin oak is generally distributed, and in most places, abundant. It is of good form for fence posts, and since it usually has an inch or more of sapwood that is easily treated, it makes a good wood for the purpose. The chief disadvantages are its weight (64 pounds per cubic foot when green), increasing the difficulty of handling, and its liability to check badly in seasoning. It is however, one of the lightest of oaks when seasoned, and checking can be largely obviated by seasoning in the woods under shade.

Red Maple is somewhat difficult to treat, and should not be used where any of the foregoing woods can be obtained readily. Its abundance and cheapness, however, strongly commend it when suitable substitutes cannot be secured on the farm.

Sycamore is very easily treated, and, except for the difficulty in peeling, and its proneness to check in seasoning, it would make an excellent wood for treatment. It is quite certain that sycamore posts, thoroughly seasoned, could be satisfactorily treated by immersion in the cold bath alone, which would greatly lessen the expense. There is, unfortunately, no accurate experimental data to prove this.

Red Birch, a wood common along streams, whence the name river birch by which it is frequently called, is not so well adapted for treating with creosote, due to irregularity of penetration. The form of the tree (usually crooked) also makes it less suitable.

Yellow Poplar is a wood easy to treat, due to the wider sap and porous structure. The difficulty is to get a proper penetration without the absorption of an excessive amount of the preservative, thereby adding unnecessarily to the cost. For this reason, with the added one that it is too valuable a wood to use when cheaper ones will do as well, or better, it should not be used for treatment.

Red oak sapwood is easily treated, but as it averages only one-half inch on the ordinary post, and the heartwood cannot be impregnated, the treatment is not satisfactory. Red oak is very heavy to handle, even when seasoned, which is a further disadvantage.

Black gum has wide sapwood, which is easily treated. The posts are difficult to peel and apt to be crooked, but they are comparatively light when seasoned, and not subject to checking. Inasmuch as black gum is plentiful, of little value for general use, and makes a good post when treated, there is no reason why farmers should not use them. It is naturally one of the least durable woods—a fact which has created a prejudice against it—but when treated it furnishes a first-class post.

Willow is hard to treat properly, and is generally so crooked as to make it hard to handle in the tanks. It should, therefore, not be used where other woods are available.

Does It Pay to Treat Fence Posts?

The answer to this question will depend upon local conditions. If good red cedar or locust posts can be readily secured for twenty-five cents each, it will scarcely pay to use treated posts. There are many localities in the State where red cedar and locust, or even chestnut, are not abundant, and some substitute must be used. It is here that treated fence posts find a legitimate field. A good example of the relative value of a durable untreated wood, as compared with a cheap treated wood, is that of locust and spruce pine at prices which prevail in the neighborhood of the Experiment Station.

TABLE VI.

Comparative Cost of Untreated and Treated Posts.

	Locust untreated.	Spruce Pine treated.
Initial cost of post	$ .25	$ .05
Cost of peeling	.03	.03
Cost of treating	.00	.10
Cost of setting	.10	.10
Total cost of post in fence line	.38	.28
Estimated length of service (years)	20	20
Annual cost of post	.019	.014

The increased durability of a cheap wood due to treatment is clearly shown in the case of sweet gum, which has been tested at the Experiment Station.

	Sweet Gum untreated.	Sweet Gum treated
Initial cost of post	$ .08	$ .08
Cost of peeling	.03	.03
Cost of treatment	.00	.10
Cost of setting	.10	.10
Total cost of post	.21	.31
Length of service (years)	3*	3
Annual cost of post	7c	1½c

*A number of sweet gum untreated posts were set at the Station two years ago. A few of them have rotted to the extent of making them unserviceable, and the others are badly decayed; hence three years is considered the average life of an untreated sweet gum post. Other species, such as black gum, sycamore, willow, yellow poplar and birch, set at the same time, show very nearly the same results.

VOLATILIZATION OF CREOSOTE.

When creosote is heated in the open tank to a high temperature, as is necessary in the hot bath (about 220° F.) a considerable volatilization of the oil takes place. In the experiments at the Station the volatilization was about 11%. In order to reduce this loss, which may be counted as a considerable item of expense, experiments were conducted with heating mediums other than creosote, with the view of finding, if possible, suitable substitutes. Oil, tar, crude petroleum and semi-liquid asphalt were used.

Crude petroleum was found to be a satisfactory substitute for creosote, its volatilization is less and its use in the hot bath did not appear

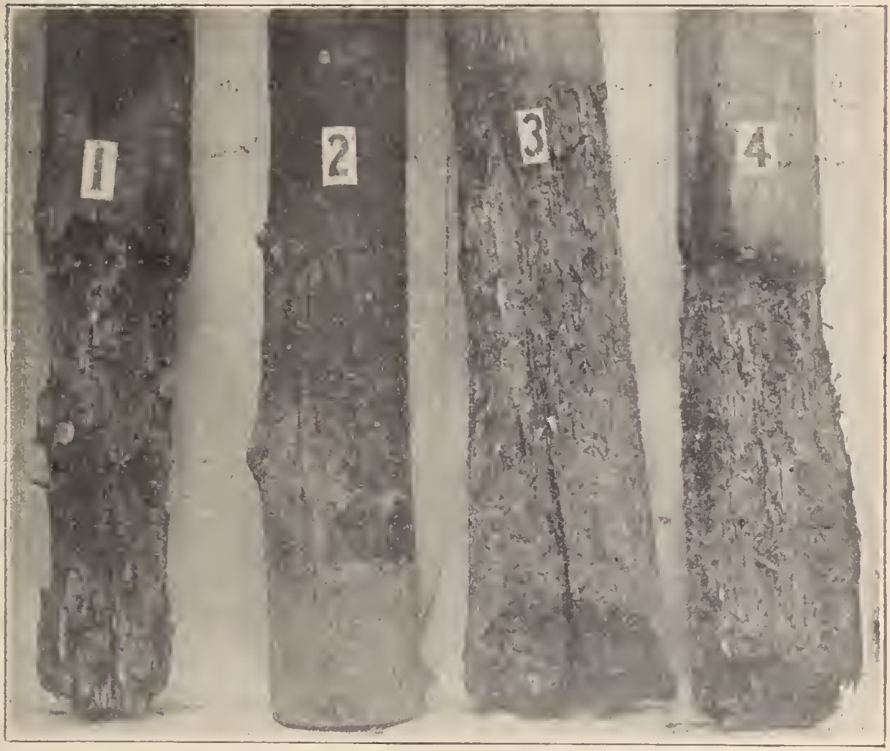


Plate IV.

Fence posts after two years service.

No. 1—Untreated spruce pine post.
No. 2—Spruce pine post treated with creosote.
No. 3—Untreated red maple post.
No. 4—Untreated sycamore post.

Note:—The treated spruce pine post is perfectly sound, while the other untreated posts are so badly decayed that they will easily break off.

to retard the penetration of creosote in the cold bath. Its low rank as a preservative makes it unsuitable for other than a heating medium.

Oil tar is a cheap oil, having a volatilization about equal to creosote, but it is less suitable than crude petroleum as a heating medium, because on continued heating it becomes viscid, forming an impervious film on the post, which renders it difficult to get a good penetration with creosote afterwards.

Semi-liquid asphalt was found to be too sticky for use, as it prevented the penetration of creosote in the after-treatment and, besides, was very difficult to handle.

Results Shown at the End of First Two Years.

A representative of the United States Forest Service, with the writer, made an examination of all of the experimental fence lines in July, 1911. At that time the posts had been in line about two years. Each post was examined from the ground line to about four inches below it, to determine the depth of decay, where any decay had taken place.

The results of the examination are shown in the following table, which records all posts where there was as much as one-eighth of an inch of decayed wood on the outside of the post.

TABLE VII.

Untreated posts that showed decay after two years' use.

Species	Tag No.	Depth of Decay	Size of Post	Total No. Untreated	No. that Failed	Percent of Failure
Sycamore	496	2 inches.	6 in.			
	505	Completely rotted off.	5 in.			
	511	Rotted off.	5 in.			
	513	Rotted off.	5 in.			
	523	Nearly rotted off.	5 in.	5	5	100
Black Gum	234	Rotted off and fallen over.	5 in.			
	235	3/4 inch.	5 in.			
	237	Rotted off.	5 in.			
	238	Rotted off.	5 in.			
	242	1-1/4 inch near ground line.	5 in.	5	5	100
Yellow Poplar...	254	1/2 inch.	4 in.			
	275	Rotted off.	4 in.			
	278	Rotted off.	4 in.			
	284	Rotted off.	5 in.			
	285	1/2 inch.	5 in.	5	5	100
Willow	734	1 inch.	7 in.			
	736	Rotted off.	4 in.			
	738	1 inch.	4 in.			
	739	1-1/4 inch almost off.	3 in.			
	740	1/2 inch.	....	5	5	100
White Poplar.....	173	1 inch.	6 in.			
	181	1-1/4 inch.	5 in.			
	185	1-1/2 inch.	8 in.			
	192	1-1/2 inch.	6 in.			
	194	1-1/2 inch.	7 in.	5	5	100
Sweet Gum......	128	Rotted off.	4 in.			
	129	Rotted off.	5 in.			
	131	1/4 inch.	4 in.			
	151	Rotted off.	2 in.	5	4	80
Birch............	870	1-1/2 inch.	4 in.			
	872	1/2 inch.	5 in.			
	889	Rotted off.	4 in.			
	891	1-1/2 inch.	7 in.			
	895	1/8 inch.	7 in.	5	5	100
Pin Oak.........	653	Rotted off.	5 in.			
	678	1/4 inch.	5 in.			
	692	Rotted off.	5 in.			
	693	Broken off.	5 in.	5	4	80

Species	Tag No.	Depth of Decay	Size of Post	Total No. Untreated	No. that Failed	Percent of Failure
Maple	761	1 inch.	5 in.			
	763	1 inch.	5 in.			
	764	Rotted off.	5 in.			
	765	1-1/4 inch.	5 in.	5	4	80
Beech	538	1-1/4 inch.	6 in.			
	543	1 inch.	6 in.	5	2	40
Pine	325	Rotted off.	5 in.			
	326	1-1/4 inch.	5 in.			
	330	1-1/2 inch.	5 in.	5	3	60
Chestnut	560	1/8 inch.	5 in.			
	588	1/4 inch.	5 in.	5	2	40
Locust	1110	1/8 inch.	5 in.			
	1113	1/4 inch.	5 in.			
	1118	1/4 inch.	5 in.			
	1121	1/4 inch.	5 in.			
	1123	1/8 inch.	5 in.			
	1124	1/8 inch.	5 in.			
	1125	1/4 inch.	5 in.			
	1131	1/8 inch.	5 in.			
	1135	1/4 inch.	5 in.			
	1137	1/4 inch.	5 in.			
	1141	1/4 inch.	5 in.	21	11	52.3

An examination of the above table shows that none of the posts that had been treated, showed any decay, except a small per cent. of those treated with liquid asphalt. This substance does not rank as a preservative, but a few posts were treated with it, to determine whether or not it had any value. The result, therefore, was not unexpected.

The important results, so far shown by the treating experiments, are:

1—That none of the posts treated with creosote, tar or crude petroleum show any perceptible decay after two years' use.

2—A large number of the untreated posts of the same kind of wood, the same size and shape as those that were treated, have decayed to such an extent as to make them unserviceable after two years in use.

3—The relative durability of the different woods used in these experiments (see page 21) that showed serious decay at the end of two years, are arranged as follows, beginning with the most durable: Locust, chestnut, spruce pine, beech, maple, pin oak, birch, sweet gum, white poplar, willow, yellow poplar, black gum and sycamore.

The fence posts will be examined from time to time, and the results published, in order that the farmers of the State may know definitely the relative durability and value of treated posts, as compared with untreated posts.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 164, JANUARY, 1912.

LIME-SULFUR AS A SUMMER SPRAY.

By J. B. S. Norton and T. B. Symons.

Introduction.

The adaptation of the lime and sulfur mixture as a fungicidal treatment for fruit trees in foliage, especially for peach, can well be considered one of the greatest modern advances in preventive treatment of disease.

Prior to the introduction of the self-boiled lime-sulfur as a preventive treatment for brown rot on peach by W. M. Scott, there was no safe treatment for this and other diseases affecting this fruit on account of the susceptibility of peach foliage to injury from bordeaux and other copper fungicides.

The general use of concentrated lime-sulfur solution as a dormant spray for scale prompted experimenters to employ the same solution greatly diluted, as a fungicide, both on apple and peach. While bordeaux mixture has been universally employed on apple, its use often resulted in injury to the fruit by russeting and burning. It was, therefore, desirable to have a new fungicide for use in general summer spraying operations.

Before the introduction of self-boiled lime-sulfur much work had been done by entomologists seeking a practical remedy for the plum curculio, a beetle that causes great injury to the fruit of peach, apple and plum. In the treatment of apple an arsenical could be conveniently combined with bordeaux, but for peach, arsenate of lead alone or with lime was the only practical remedy that could be employed against this beetle, and this could not be safely recommended, on account of possible injury to foliage. Hence it was very desirable to have a fungicide with which the arsenical could be combined in the treatment of peach, as well as apple, to prevent the attack of this pest.

The purpose of this bulletin is to point out the necessity of summer spraying of peach and apple trees to secure a good quality of fruit, to report the results of co-operative work conducted by the writers during the past two years, and to cite briefly some of the worst diseases and insects attacking peach and apple fruits and recommendations for their control.

Grateful acknowledgment is made to the various orchardists in the State who have aided us in carrying out these tests, including Aaron

Newcomer, Smithsburg; W. W. Byrn, Cambridge; G. F. Wathen, Loveville; C. W. Keller, Harper's Ferry; W. J. Hoffman, Ridgely; J. G. Harrison & Sons, Berlin; as well as others who have carried on co-operative tests.

Credit is due A. J. Norman, Associate Pathologist, in 1910, for the work here reported for that year. The spraying tests and the recording of notes the past year was done by Assistants O. G. Babcock, H. H. Jewett and J. B. Demaree.

Fungus and Insect Pests of Peach and Apple.

While the lime-sulfur sprays may be used upon other fruit and to some extent on garden and field crops, their chief use in Maryland will be upon peach and apple. For convenience, the chief diseases of these fruits are given below, with the most characteristic symptoms of each.

Peach Scab, forms dark spots on one side of the fruit, which may be so abundant as to cause a black scab with cracking and shriveling of the fruit. It winters over in the spots on twigs or on mummy fruits and begins to appear in early summer.

Brown Rot, is the common rot of the fruit, usually seen at ripening time in wet, warm weather. It also sometimes kills blossoms and twigs. It winters over in the mummy fruits. The gray powder of spores on the rotten fruits spread it during summer, and the spores on the partially buried two-year old mummies disseminate it in spring. It attacks the fruit especially through wounds, such as curculio stings. It is bad also on plums, etc.

Peach Leaf Curl, causes the peach leaves to become curled or distorted early in spring. If bad, the trees may lose most of their foliage and also the fruit. As the fungus begins to grow, as soon as the buds start to swell, any effective treatment must be given in the dormant period. It is much worse on some varieties, Elberta, for example.

Peach Yellows, recognized by the prematurely ripening fruit with characteristic red spots and slender twigs with narrow, usually yellow foliage, is a functional disease, due to unknown causes, and *cannot* be treated by spraying, but destruction of the affected trees is practiced to prevent the spread of the disease to others.

Bitter Rot of Apple, appears after the middle of June as slightly sunken, rotten, usually bitter spots, with spores produced in concentric rings on the rotten area, which extends deeply into the flesh. It may attack both green and ripe fruit.

Apple Blotch, appears as dark spots on the fruit, with irregular fringed margin. If severe the fruit cracks.

Apple Scab, forms dark spots in the skin of the apple surrounded by a faint, lighter ring of loose epidermis; also causes olive green or brown, distorted areas on leaves, which fall and carry the fungus over winter. In bad cases on young fruit, the apple cracks or is one-sided. The disease begins as soon as the buds commence growth in the spring.

Black Rot of Apple, is distinguished from bitter rot by the less sunken area, with black dots irregularly arranged on its surface. It is not bitter, is less sunken and attacks chiefly the ripe fruit. It also causes the common leaf spot.

Apple or Cedar Rust, causes the well-known cedar apples, from whose gelatinous outgrowths in spring, spores transmit this disease to apple leaves or even fruit and twigs, causing a thick, yellow or orange-colored spot. Cutting out the cedars in the surrounding country is the best preventive.

Sooty Blotch or Flyspeck fungus, causes unsightly or dirty spots on the apple surface, but the skin or flesh is not injured.

Fruit Spot, appears as small, slightly sunken, discolored spots on the fruit in late summer, usually near the blossom end; later they may turn dark and decay.

Blight of apple, pear and quince, causing the death of the twigs from the tip backward, or often girdling the bark on larger branches or producing collar rot at the base of trees, is usually recognized by the dead twigs with the blackened leaves still hanging on. It cannot be controlled by spraying, but must be cut out, disinfecting the pruning instrument after each cut.

There are only two principal insect pests that attack the fruit of peach and apple, the codling moth and the plum curculio.

Codling Moth is a small moth with a wing expense of about one-half to three-fourths of an inch. It usually winters as a larva, pupates in early spring and the adult moth appears about the middle of April or first of May, when the apple trees are in bloom. Eggs are laid either on the foliage of the apple or in the blossom. In from six to twelve days the eggs hatch and the larva either crawls to the nearest apple or immediately commences eating its way into the young fruit. Infested fruit usually drops from the tree before normal ripening time and rots on the ground. Of the infected fruit that does hang on the trees until picking time, a great percentage is undersized and misshapen. There is a second generation of the insect, and this often causes more direct injury than the first. Applications of an arsenical at proper time is a practical remedy for this pest.

Plum Curculio, a small dark brown snout beetle, causes much more injury to the fruit of peach, apple and plum than is generally appreciated by the average grower. After wintering as an adult it appears in early spring and commences feeding on foliage and fruits. These feeding punctures on the small growing fruits furnish openings for disease and also scar them badly. Later, the female beetles do greater damage by depositing their eggs in crescent-shaped cuts in the skin of the fruit. The eggs hatch in a few days and the larva feeds into the center of the attacked fruit, causing it to ultimately drop and rot.

Experiments.

Experiments were conducted in 1910-11 to complete work previously done (Bulletin No. 143) on self-boiled lime-sulfur, and to ascertain the value of concentrated lime-sulfur and similar preparations for summer spraying under Maryland conditions, a number of Stations having reported favorably on this material during the previous year; also to test various arsenicals in combination with these sprays. In addition to the experiments here reported some co-operative work taken up by various fruit growers is published under the head of "Fruit Growers' Opinions," in the Report of the Maryland State Horticultural Society, Vol. 13, page 143, 1911. The tests made were as follows:

1910.

1. Aaron Newcomer's orchard, Smithsburg, Washington County. Concentrated lime-sulfur, 1-200, 1-160, and 1-133 of water with 2 pounds lead arsenate per barrel; 1-133 lime-sulfur without lead arsenate; and 2-6-50 bordeaux for comparison; on Stevens Rareripe, Red-cheeked (Melocoton), Crawford and Chairs (Choice) peach, May 10, June 9, and July 6, on about 10 trees each.

Results: Leaf injury varying inversely to the quantity of lime-sulfur used, being more serious with the weaker solution and none on the test without lead arsenate, and no injury from bordeaux. The checks were very scabby. The imperfect bordeaux treatment gave some protection from scab, while the stronger lime-sulfur spray gave about 30 per cent. entirely free from scab and over 90 per cent. of very clean fruit. Very little rot was present this season.

2. W. W. Byrn's orchard, Cambridge, Dorchester County. Concentrated lime-sulfur, 1-150, with 4 ounces paris green per barrel and 2-8-50 bordeaux with 4 ounces paris green, April 14; same without arsenical, May 17; on about 15 Elberta peach.

Results: Severe leaf injury from the first spraying with lime-sulfur and from the second bordeaux spraying. The fruit from the sprayed trees was more highly colored and nearly 10 per cent. smaller than on the unsprayed. There was little difference in the amount of diseased fruit.

3. G. F. Wathen's orchard, Loveville, St. Mary's County. Concentrated lime-sulfur 1-200 on peach and plum, and 1½ to 50 on apple, and bordeaux on apple and peach, all with arsenical, April 19; same, May 24th and last of June, except that no arsenical was used on peach.

Results: Much loss of leaves on peach; some on apple, but less with bordeaux, though it russeted fruit. Scab and leaf spot were not controlled. Brown rot was slightly controlled but fruit small. Most fruit diseases that were present on apple were well controlled by both bordeaux and lime-sulfur.

1911.

1. Walter Hoffman's orchard, Ridgely, Caroline County. Self-boiled lime-sulfur 8-8-50, concentrated lime-sulfur 1-180, each with 2 pounds lead arsenate per barrel; lead arsenate 2 pounds, lime 3 pounds,

water 50 gallons; atomic sulfur (various strengths) and sulphocide 1-500, all applied to Elberta peach May 12, May 30, and June 29, on 15 trees each.

Results: Scab was common, though not serious in the orchard and rot rare except on injured fruit. The self-boiled lime-sulfur gave the best results, 83 per cent. of almost perfect fruit, practically no rot, and 14 per cent. of fruit with more or less scab. Atomic sulfur gave a fair per cent. of perfect fruit, but injured the foliage somewhat. The others were of little value and some caused marked injury.

2. C. W. Keller's orchard, Washington County, near Harper's Ferry. Self-boiled lime-sulfur 8-8-50; concentrated lime-sulfur, 1-80; 1-125, 1-150, all with 2 pounds arsenate of lead per barrel, for 1st and 2nd applications; 3 forms atomic sulfur; sulphocide 1-500; lead arsenate and lime 2-3-50. All applied to peach May 19, June 2, June 28th, about 30 trees for each spray. A number of different treatments were given to apple in this orchard at about the same dates as on peach, including concentrated lime-sulfur 1-25, 1-40, sulphocide 1-200 4-5-50 bordeaux atomic sulfur and "waste water."

Results: Peach sprayed with self-boiled lime-sulfur and one form of atomic sulfur were almost entirely free from scab and rot. The concentrated lime-sulfur 1-80 showed only 4 per cent. of rot and scab; the 1-125, 4.5 per cent. rot, 13.3 per cent. scab; the 1-150, 5 per cent. rot, 19.3 per cent. scab. All the atomic sulfur sprays were free from rot; one showed 14 per cent. scab. The sulphocide was of no value in disease control and caused much injury. The unsprayed trees showed very little rot and about 46 per cent. scabby fruit. The different sprays containing lead arsenate gave from 12-20 per cent. of fruit injured by curculio, except the lead arsenate and lime which showed less than 6 per cent., against 35.5 per cent. on checks. This spray also gave some protection against scab, showing only 10 per cent. scabby fruit.

There was very little disease on the apple in this orchard. Practically all the sprays used gave considerable reduction of codling moth over the checks. The paris green or lead arsenate with bordeaux being the best. The "waste water" caused very serious injury to the foliage; bordeaux caused very little injury; concentrated lime-sulfur caused some injury to both fruit and foliage, the atomic sulfur not so much; the sulphocide seriously injured the foliage.

3. J. G. Harrison & Sons' orchard, Berlin, Worcester County. Self-boiled lime-sulfur 8-8-50; concentrated lime-sulfur, 1-50; 1-80; 1-125; each with 2 pounds lead arsenate per barrel for 1st and 2d application; 3 forms of atomic sulfur; sulphocide 1-500, all applied to peach, May 5-6, June 5-6, June 27, and lead arsenate and lime 2-3-50 applied May 5 and June 5. The majority of the orchard was sprayed by the owners with self-boiled lime-sulfur, without lead arsenate. Bordeaux and concentrated lime-sulfur of different strengths in combination with lead arsenate and paris green, self-boiled lime-sulfur, atomic sulfur and sulphocide were applied to apple and pear at the same dates.

Results: On peach self-boiled lime-sulfur gave fruit almost absolutely without spot or rot; leaves were injured to the extent of 10 per cent. to 25 per cent. evidently due to arsenate, as the whole orchard sprayed with self-boiled lime-sulfur without lead arsenate had less leaf injury. With atomic sulfur the leaves dropped badly, fruit was injured some and many dropped, there was about 3 to 5 per cent. of rot, but mostly in cracks caused by the spray, scab 5 per cent. Sulphocide gave an excellent condition and good color to foliage; rot none; scab about 50 per cent. No leaf injury, 5 per cent. of rot; 99 per cent. of scab, but none so severe as to cause cracking, showed on the checks. Very little curculio was present in the orchard.

On apple there was very little opportunity for accurate comparison on account of mixed varieties in the test rows, but it may be said that the self-boiled lime-sulfur did not control leaf spot, bitter rot or blotch; concentrated lime-sulfur controlled all apple diseases present except bitter rot, but caused much leaf injury, even in 1-50 concentration; bordeaux caused very little injury and controlled well all diseases. Atomic sulfur showed little injury and fruit free from most diseases except bitter rot. Sulphocide caused marked injury and did not control rot but fruit was otherwise clean.

Summary of Results.

The following conclusions of use to Maryland orchardists can be drawn from the foregoing:

1. Self-boiled lime-sulfur 8-8-50 is an excellent protection against peach scab and the best treatment for rot, in view of the risk of injury from bordeaux. It is scarcely effective against most apple diseases.
2. Concentrated lime-sulfur if diluted sufficiently will control to a great extent scab and rot of peach, but with some danger of foliage injury. In considerably stronger dilutions, say 1-40, it is effective for most apple diseases, except bitter rot, but with some danger of injury. It is not so good a fungicide as bordeaux but does not russet apples like the latter, the chief danger of injury being in leaf burn and a sun burn, like injury on the side of fruit exposed to the sun.
3. Sulphocide if used strong enough for an effective fungicide, usually causes marked injury to foliage.
4. With atomic sulfur, the results obtained were too variable to be conclusive.
5. Arsenate of lead in the usual amount with lime-sulfur may cause some injury to peach foliage, but it is believed that this is the best combination that can be effective for curculio.

The Necessity of a Summer Spray.

Maryland orchardists spray regularly for the San Jose scale, which also controls peach leaf curl. The majority of the up-to-date growers spray their apple trees just as the blossoms fall for codling moth, and at this treatment combine the arsenical with a fungicide, either bordeaux, which has previously been exclusively used, or concentrated lime-sulfur, employed by many during the past season. But in the majority of cases after the above treatment, spraying is not thought of until another season. Practically no spraying is done for the plum curculio, brown rot, scab, etc., on peach, and but few apple growers treat for bitter rot, fruit and leaf spot, rust and other diseases on apple fruit and foliage. The losses to our growers for this neglect amounts to thousands of dollars yearly.

There have been hundreds of instances where the hopes of remuneration from a good peach crop have been blasted by brown rot, and good sized peaches have brought poor returns owing to a bad infection of scab. Moreover, it is a common sight to see apples seriously affected by one or more diseases, making the crop from many trees practically unsalable. In order to prevent these losses, our growers must practice late spring and summer spraying.

RECOMMENDATIONS.

From the results of work reported and our observations in the treatment of thousands of trees in the State, as well as the work of Scott and Quaintance, Farmer's Bulletin No. 440, United States Department of Agriculture, we would recommend the following treatment as being the most effective and practical to control the pests mentioned. It is presumed that all up-to-date growers will spray their trees while dormant for the control of scale and leaf curl.

TREATMENT FOR PEACH IN FOLIAGE.

Just as the shucks or calyxes are dropping from the young peaches, the trees should be sprayed with arsenate of lead, using 2 pounds lead and 2 pounds lime to 50 gallons of water.

The second spraying should be applied about two weeks after the first. This treatment is primarily to prevent scab and various other diseases. The self-boiled lime-sulfur 8-8-50, should be used, and it is advisable to again add 2 pounds arsenate of lead in order to kill late appearing curculio.

A third spraying with the self-boiled lime-sulfur, 8-8-50 alone should be applied about a month before the peaches will ripen to prevent brown rot.

These three sprayings will usually insure a good crop of fruit, which will be practically free from fungous diseases and curculio marks. The cost of the work is insignificant in comparison with the quality and quantity of good, salable fruit produced.

For late varieties add a treatment of self-boiled lime-sulfur alone three or four weeks after the second application.

For very early varieties the third spraying should be omitted. If it is only possible to give one application, the second is most important.

TREATMENT FOR APPLE IN FOLIAGE.

In addition to the dormant spray for scale, apple trees should be sprayed before the blossoms open, or just as they begin to show pink, with concentrated lime-sulfur, diluted at the rate of one and one-half gallons of the manufactured product to 50 gallons of water. This spraying is applied to prevent early scab infection. Early infection from this fungus may often cause a dropping of the young forming fruits resulting in a light crop, and be responsible for leaf injury later on. As scab is not often serious here, in the vast majority of cases this spraying is omitted by Maryland growers, their dependence being placed in the next spraying.

The second treatment should be applied just as the blossoms are falling, using the concentrated lime-sulfur 1-40 to which is added 2 pounds arsenate of lead. This combined spray serves to further check the development of scab and injury from the codling moth. This treatment should be very thorough, as it is usually the most important of all.

A third spray with a like solution about two weeks after the second is advisable though not always necessary. More particularly is it necessary to prevent attack from disease than late appearing codling moths.

A fourth treatment, about eight weeks after the blossoms fall, or about the first of July, is quite necessary, not only to prevent injury from the second brood of codling moths, but attacks of bitter rot and other diseases. In all these sprayings the same combined concentrated lime-sulfur 1-40 and 2 pounds arsenate of lead can be used.

As pointed out elsewhere, bordeaux mixture has been used in the past in the place of concentrated lime-sulfur, but we believe that the latter is more desirable as a fungicidal spray for apple except in case of treatment for bitter rot, in which the last spraying should be made with bordeaux, as lime-sulfur is not a sufficiently strong fungicide for this disease. In making bordeaux, use the 4-5-50 formula, viz., 4 pounds copper sulphate, 5 pounds lime to 50 gallons of water, 2 pounds arsenate of lead being added to form a combined spray.

The treatment here recommended for apple will apply to pear, and the treatment recommended for peach will likewise apply to plum. Both of these fruits should be treated as regularly as peach and apple to secure good results.

Finally, orchardists should not confuse the two lime-sulfur compounds, remembering that the self-boiled is only used on peach, plum and other tender foliage plants, while the concentrated solution, which is used as a dormant spray for scale, is used as a fungicide on apple and pear foliage, but much diluted.

Preparation of Self-Boiled Lime-Sulfur.

Use eight pounds of flowers or flour of sulfur, eight pounds of stone lime, to fifty gallons of water. The mixture should be made in a kettle, barrel or receptacle of sufficient size. Better results can be obtained with larger quantities. The necessary amount of unslaked lime should be placed in the receptacle and a sufficient amount of water poured on the lime to start it slaking. When the lime begins to slake, add the eight pounds of sulfur. Stir the mixture and add water as needed to keep a pasty condition until the lime is all slaked. Do not allow any dark, yellow color to form, as it will if the heat becomes too great at any point. If the sulfur is lumpy, it may be put in a finely divided condition by passing it through a fine mesh sieve. The heat generated by the slacking lime causes the sulfur to mix physically with the lime in very fine state, but should not be continued to form much of the sulfide combination indicated by the yellow or brown color. Therefore, it is essential that the proper amount of water be added to cause a violent boiling of the mixture for a few minutes, and as soon as the lime is well slaked, add cold water to make the required amount. The self-boiled lime-sulfur is now ready for use. The time to allow the mixture to boil will vary accordingly to the lime used, as some lime will slake more quickly than others. It should show only a faint yellow color before diluting.

In case of spraying a commercial orchard, it is advisable to prepare larger quantities in order to secure more uniform results. The mixture settles rapidly and *requires thorough agitation.*

BORDEAUX MIXTURE.

Dissolve the number of pounds of blue-stone indicated by the first figure of the formula, in a few gallons of water. Fill the spray barrel two-thirds full of water and add the dissolved blue-stone. Slake the number of pounds of lime indicated by the second figure of formula by slowly adding water until it becomes a thin paste. Wash the lime through a twenty-mesh sieve into the solution in the spray barrel, adding water until there is fifty gallons of the whole. Agitate thoroughly and the mixture is ready to apply.

Those desiring further information on bordeaux may secure it in Bulletin No. 143 of this Station, or Farmer's Bulletin No. 243, United States Department of Agriculture.

CONCENTRATED LIME-SULFUR.

This lime-sulfur compound can either be made by the orchardists or purchased ready prepared. As so small an amount is used for summer spraying it is usually best to employ the manufactured product. The solution is usually diluted at the rate of one gallon to 40 of water, for spraying apple trees in foliage. The large orchardist will find it usually more economical to make his own solution. Full directions for making the solution are given in Bulletin No. 161.

Arsenate of lead and concentrated lime-sulfur solutions can be secured from many responsible insecticide firms. Among them are: The Thomsen Chemical Company, Baltimore, Md.; The Grasselli Chemical Company, New York City; The Vreeland Chemical Company, New York City; The Niagara Spray Company, Rochester, N. Y., etc.

PROMPT AND THOROUGH SPRAYING.

Too much importance cannot be attached to the necessity of promptness in the treatment for these pests. Often a delay of a week or more after the proper time will result in a considerable loss. Moreover, the spraying should always be as thorough as possible. The method of application has much to do with results. The grower should provide himself with good apparatus in the form of pumps, hose, nozzles, etc. Where there is much spraying to be done, a good power outfit should be secured. The proper distribution of the spray can best be obtained by using high pressure through a small hole nozzle, which will produce a fine mist. Extended discussion of spraying apparatus has been given from time to time in bulletins from this Station, and will not be repeated here. Anyone desiring specific information concerning the matter should communicate with the Station.

CONCLUSION.

In conclusion, the writers urge again the importance of summer spraying on all kinds of tree fruits. The demand of markets is for clean fruit, and usually this can only be secured by preventive treatment. Some seasons demand it more than others, but it always is the wisest and best policy to give the regular treatment every year.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 165. FEBRUARY, 1912.

BOYS' CORN GROWING CONTEST IN 1911. SUGGESTIONS FOR CORN GROWING AND CONDUCTING A CONTEST.

By NICKOLAS SCHMITZ AND WALLACE E. HANGER.

OUTLINE OF TEST IN 1911.

In this bulletin are reported the results of a boys' corn-growing contest conducted in 1911, under the supervision of the Maryland Agricultural Experiment Station, in Anne Arundel, Baltimore, Harford, and Frederick Counties. In many cases teachers and others connected with the public schools gave material assistance to the Station in the way of sending in, and distributing information; besides doing a great deal to encourage the boys to enter the contest, and to keep up their enthusiasm after entering. The prizes amounted to $350 and were given by individuals, farmers' organizations, school organizations and a newspaper. Forty-five per cent. of those who entered remained in the contest to the end.

Each contestant, excepting those in Anne Arundel and Frederick counties, first made an agreement with his father or guardian by which he was to receive the net profit of the acre of corn grown by him whether he won a premium or not. All entering the contest were required to plant and cultivate the crop, excepting in a few cases where the boys were too small to do the heavy work. The contestants kept an account of the amount and cost of commercial fertilizer applied; the amount of barn-yard or stable manure used; and, in addition, an account of the time and manner of working the land before and after planting the crop, and the amount of man and team labor required to grow the corn.

Members of the Maryland Agricultural Experiment Station visited each contestant twice; the first time (September) measuring the land and counting the number of ears on the acre, and the second time weighing the corn.

A fifty-pound sample of average ears was taken from each acre and sent to the experiment station, where the corn was shelled and the percentage of shelled corn and moisture determined. These percentages were then used for calculating the yield of air-dry shelled corn. In Baltimore and Harford Counties the awards were based upon the yield of air-dry shelled corn grown on the acre at the greatest net profit, allowing 60 points for yield and 40 for net profit. In Anne Arundel and Frederick Counties the yield of air-dry shelled corn only was considered in awarding the premiums.

In calculating the net profit commercial fertilizer and lime were figured at cost, but for all other expenses, including manure, man and team labor, a uniform charge was made. Corn was valued at sixty-three cents per bushel.

The following table gives the complete data of the crops of 54 boys in the contest:

Name of Contestant.	Post Office.	County.	Total Gross Wt.	Per Ct. Moisture at Shelling Time.		Total Percentage of Moisture at Husking Time	Percentage of Shelled Corn.	Yield Bu. of Air Dry Shelled Corn 15 Per Ct. M.	Cost of Production.	Net Profit.	Crops Grown on Land Preceding Three Years.		
				Corn.	Cob.						1908.	1909.	1910.
Chas. Williard Amos	Scarff	Harford	8322.7	20.0	36.3	24.39	85.8	113.6	16.05	55.51	Potatoes	Wheat	Grass
Henry Hopkins	Aberdeen	Harford	7173.6	18.4	25.0	19.46	85.1	103.3	23.40	41.67	Grass	Grass	Grass
Milfred Miller	Parkton	Baltimore	6962.0	20.1	33.1	25.20	85.8	94.0	21.25	37.97	Potatoes	Wheat	Clover
Robert Cronin	Perryman	Harford	6557.9	20.2	36.0	24.76	83.55	86.5	13.80	40.69	Idle	Wheat	Pasture
Samuel V. Davis	Joppa	Harford	6312.0	19.0	24.0	19.97	82.25	87.3	15.39	39.60	Grass	Grass	Grass
Walter Lloyd	Sparks	Baltimore	6617.9	18.2	29.1	23.85	83.93	88.8	18.94	37.00	Corn	Rye	Cowpeas
Andrew Leach	Monkton	Baltimore	6328.8	20.5	39.3	25.54	85.72	84.8	21.30	32.12	Grass ½ Corn ½	Corn ½ Potatoes ½	Wheat ½ Alfalfa ½
Marshall Wilson	Pylesville	Harford	5989.5	21.0	29.0	23.69	83.43	80.0	16.55	33.85	Timothy Clover	Timothy Clover	Pasture
Thomas Stiffler	Forest Hill	Harford	5566.3	19.8	33.7	25.06	84.91	74.4	9.20	37.67	Wheat	Grass	Grass
Russel Galbreath	Street	Harford	5266.0	17.0	20.0	18.59	85.56	77.1	13.20	35.37	Wheat	Grass	Grass
Franklin De Baugh	Brooklandsville	Baltimore	5562.1	21.4	26.4	23.91	81.79	72.7	8.92	36.88	Grass	Grass	Oats
William Kauffman	Bentley Springs	Baltimore	5921.0	20.8	37.6	26.93	84.14	76.4	14.27	33.86	Clover	Timothy	Pasture
Burris Dalton	White Hall	Baltimore	6078.3	19.8	29.6	25.55	84.02	79.8	19.80	30.47	Pasture	Pasture	Pasture
Russel Hoshall	Freeland	Baltimore	5823.7	22.8	47.6	31.36	86.03	72.2	10.90	34.58	Wheat	Wheat	Grass
Clinton D. Almony	White Hall	Baltimore	5730.5		No	Sam	ple	73.0	16.20	29.97	Grass	Grass	Grass
Albert Bleakley	Garrison	Baltimore	5600.8	22.6	40.5	28.33	84.21	71.1	14.00	30.79	----	----	----
Coulson C. Hendrix	Freeland	Baltimore	5661.3	21.8	34.2	26.73	83.65	72.8	16.90	28.96	Wheat	Wheat	Clover
Max Tarbert	Glencoe	Baltimore	6155.0	23.4	46.0	30.61	85.49	76.7	22.70	25.63	Corn	Clover	Wheat
Elwood Bartel	Garrison	Baltimore	5330.3	22.2	42.4	27.71	84.42	68.4	12.32	30.77	Corn	Oats	Potatoes
Salem Roysten	Glencoe	Baltimore	5054.4	18.6	31.4	23.32	84.12	68.5	13.40	29.75	Oats	Idle	Pasture
Sylvester Prigel	Gittings	Baltimore	5230.5	18.1	27.4	22.19	84.69	72.5	21.35	24.32	Wheat	Clover Timothy	Timothy
Edward S. Klohr	Randallstown	Baltimore	5285.0	20.7	36.8	31.88	84.51	63.9	12.72	27.54	Grass	Grass	Potatoes
Abram Pearce	Sparks	Baltimore	4882.9	18.6	24.1	20.57	82.81	67.4	18.70	23.76	Wheat	Grass	Grass
Charles Costa	Sparks	Baltimore	5078.8	21.6	33.3	28.56	83.18	63.4	14.07	25.87	Wheat	Grass	Grass
John Buecker	Rocks	Harford	4694.6	18.5	28.8	23.43	83.75	63.2	15.66	24.16	Wheat	Grass	Grass
Russel Lord	Cockeysville	Baltimore	4720.0	17.6	24.2	26.04	84.96	62.3*	17.00	22.25	Grass	Wheat	Corn

Name of Contestant.	Post Office.	County.	Total Gross Wt.	Per Ct. Moisture at Shelling Time.		Total Percentage of Moisture at Husking Time.	Percentage of Shelled Corn.	Yield Bu. of Air Dry Shelled Corn 15 Per Ct. M.	Cost of Production.	Net Profit.	Crops Grown on Land Preceding Three Years.		
				Corn.	Cob.						1908.	1909.	1910.
Lee Bosley	Cockeysville	Baltimore	4878.9	22.6	45.0	32.46	82.96	57.4	11.23	24.93	Grass	Grass	Grass
Walter Ortel	Colgate	Baltimore	3914.0	17.4	28.6	19.31	84.87	56.3	9.76	25.71		Potatoes	Spinach
Milton Geist	Cockeysville	Baltimore	4390.0	25.4	46.4	35.79	83.97	49.7	15.00	16.31	Grass	Grass	Grass
Clarence Galbreath	Street	Harford	4132.0	19.6	29.2	25.37	85.10	55.1	10.75	23.96	Wheat	Wheat	Grass
Wilbur Routson	Freeland	Baltimore	4548.5	20.4	35.5	28.48	84.12	57.5	14.40	21.82	Wheat	Clover	Timothy
John Galbreath	Street	Harford	4139.8	20.0	29.4	25.99	84.70	54.5	10.55	23.78	Wheat	Wheat	Grass
Monroe McCormick	Bel Air	Harford	6418.0	22.2	36.4	26.61	83.20	82.4	49.60	2.31	Tomatoes	Wheat	Clover
Rosario Costa	Sparks	Baltimore	4356.6	22.7	41.0	30.57	84.03	53.4	13.22	20.42	Wheat	Grass	Grass
Carlton Chilcoat	Glyndon	Baltimore	4422.2	23.0	46.7	30.52	86.67	55.9	17.50	17.71	{Clover }Timothy	Timothy	Timothy
William Williamson	Woodlawn	Baltimore	4074.1		No	Sam	ple	51.0	11.95	20.18	Pasture	Pasture	Pasture
Calvin Hershner	Parkton	Baltimore	5270.1	27.4	47.0	38.45	83.00	56.6	22.79	12.87	Corn	Potatoes	Wheat
Roger Williams	Freeland	Baltimore	4766.4	23.2	36.0	31.21	81.41	56.1	22.60	12.74	Wheat	Clover	Clover
Ernest Wilson	Parkton	Baltimore	3133.6	20.8	33.2	26.98	85.35	41.0	9.47	16.36	Potatoes	Wheat	Grass
Bergen F. Brown	Freeland	Baltimore	3470.6	23.2	39.0	30.61	82.74	41.8	12.75	13.58	Oats	Wheat	Clover
Kyle Upton	Woodlawn	Baltimore	3147.0		No	Sam	ple	40.0	15.75	9.45	Grass	Grass	Grass
Paul Gore	Freeland	Baltimore	3129.2	22.0	38.0	28.80	86.34	40.4*	17.65	7.80			
Thorne Parry	Glencoe	Baltimore	2909.2	24.0	39.8	32.57	82.09	33.8	11.40	9.89	Clover	Timothy	Pasture
James Ridout	Annapolis	Anne Arundel	3382.0	21.6	38.9	25.2	83.01	44.1	11.60	16.18	Timothy	Timothy	Potatoes
Stephen Gomoljak	Parole	Anne Arundel	3051.0	32.7	54.2	38.36	80.46	31.8	6.58	13 24	In Woods	Sugar Corn	Wheat
Herbert Hall	Davidsonville	Anne Arundel	2603.0	25.3	42.6	29.3	81.24	31.6	7.58	12.33	Corn	Corn	{Timothy }Red Top
Edward Gertz	Millersville	Anne Arundel	1800.0	23.3	60.8	31.3	87.84	22.8	5.54	8.82	Willows	Willows	
Robert Turner	Gambrills	Anne Arundel	1738.0	20.5	26.9	21.8	81.02	23.2	9.00	5.61	Tomatoes	Cucumbers	Sweet Corn
William Adams	Gambrills	Anne Arundel	1140.0		No	Sam	ple	15.00	6.30	3.15	Pasture	Pasture	Pasture
Glen Putman	Lewistown	Frederick	5891.4	18.2	32.0	23.53	85.72	81.1	16.70	34.39			Wheat
Chester Summers	Myersville	Frederick	4693.0	19.0	25.3	24.30	84.3	62.9	7.90	31.73	Wheat	Timothy	Timothy
George Leatherman	Myersville	Frederick	5104.0	18.2	32.2	26.56	83.71	65.9	19.44	22.08			
C. Cyril Klein	Frederick	Frederick	4192.0	19.1	29.0	22.88	83.01	56.4	8.82	26.71	Grass	Corn	Wheat
Geo. David Hoover	Graceham	Frederick	3926.0	21.7	35.6	23.98	86.10	53.9	13.43	20.52	Grass	Grass	Wheat

METHOD FOLLOWED BY PRIZE WINNERS.

The following are the statements of the boys ranking first, second, third, fourth, fifth and seventh in the Contest between Baltimore and Harford Counties, and give somewhat in detail the treatment and manner of growing their acre of corn.

CHARLES WILLIARD AMOS—RANKING FIRST IN CONTEST.

"The first thing I did after measuring off my acre was to haul a load of horse-stable manure and put it on a little knoll which I thought was the poorest part. On April 29th I plowed and rolled the land. During the next twelve days I harrowed it twice, rolled it once, and put on with a grain drill 550 lbs. of Berg's Special Bone Manure, analysis 3-9-4. On May 11th I planted the corn, drilling it with corn planter. The rows were three feet apart and the corn in row averaged eight inches apart. I cultivated it three times, as follows: June 3d, 16th and 21st. On July 1st I put around the corn a bag (167 lbs.) of Baugh's Complete Animal Bone, analysis 2-8-5, and worked it in with shovel plow."

HENRY HOPKINS—RANKING SECOND IN CONTEST.

"My acre of ground was a 23-year-old sod. About the middle of April eight loads of stable manure were spread on the land; a little later in the month 350 lbs. of German Kanit were put on and the land plowed to depth of six or seven inches. After plowing 450 lbs. of Baugh's 2-8-2 goods were applied, and the land harrowed once with spike tooth, three times with spring tooth and rubbed once. Corn was planted May 11th, with a Black Hawk planter, sowing 250 lbs. Baugh's fertilizer in the row. About 10 quarts of corn were used for planting. On May 22d harowed corn with spike tooth harrow. On May 20th cultivated with sulky cultivator. On June 1st the corn was thinned and when it was about knee-high 400 lbs. of Baugh's fertilizer were sowed on. The latter cultivations were as follows: June 10th, June 23d. June 27th. On July 1st the corn was hoed and thinned."

MILFRED MILLER—RANKING 3D IN CONTEST.

"My acre received 8 two-horse loads of manure which was mostly decayed straw. This was plowed under April 16th. I used 500 lbs. of fertilizer, the analysis of which was 1½-8-9, 350 lbs. being drilled on and the rest put in the hills. I harrowed the land three times, rolled it twice, and planted it by hand in hills 3 feet by 2½ feet on May 4th. The first planting did not come up very well, one-half of it I had to replant on account of drought. I cultivated it four times."

ROBERT CRONIN—RANKING 4TH IN CONTEST.

"My acre of land laid idle in stalk ground in 1908, being sown to wheat that fall. In 1909 it was pastured after harvesting the wheat, and in 1910 it was pastured. During summer of 1910 a few loads of corn stalks and rubbish of poor quality were spread upon it. Land was plowed about the middle of March, 1911, and allowed to lie until May 12th. Then it was harrowed and rubbed five times and planted May 18th. I sowed on broadcast 500 lbs. of Woolridge fertilizer, the analysis being 3-7-8. The corn was worked as soon as it came through the ground on June 4th, but after that it was so wet and corn grew so fast that I could cultivate it only once more, on June 25th. The corn was planted three feet square. A heavy wind-storm blew it over twice. When we went to cut the corn off we had to cut a place for the shock."

SAMUEL VERNON DAVIS—RANKING 5TH IN CONTEST.

"The land was a sod plowed in November, 1910, five inches deep. It was mowed the same year at harvest time, and also the two years preceding. The land had received no top-dressing in the three years. No work was done on the land after plowing until April 19, 1911, when it was disc-harrowed to a depth of about four inches. On April 29th I applied 500 pounds of South Carolina Rock, drilling in about one and one-half inches. On May 6th it was harrowed both ways with spring-tooth harrow three inches deep. The land was marked off on May 8th with marker, making rows three feet and two inches apart and corn drilled with a Planet, Jr. hand-drill, just covering the corn. Five quarts of carefully selected corn were used. After planting the ground was worked with double cultivator and rolled down firmly. As soon as corn came up it was worked with double cultivator four inches deep and as close as possible. It was replanted and later thinned. It was worked again with double worker two inches deep and laid by when five feet high with single cultivator going twice in a row and just deep enough to break the crust and kill the weeds that were coming up."

ANDREW LEACH—RANKING 7TH IN CONTEST.

"My acre was put in as we usually plant corn here except that after harrowing the land three times, it was disced with a cutaway harrow. Six hundred pounds of a mixture of Rock and bone were drilled on and corn planted with corn planter set at 11 inches. The corn was worked six times with double cultivator and afterward hoed out between rows. On July 3d 100 pounds of Nitrate of Soda were sowed on and worked in with shovel plow, and another dressing of 100 pounds of Nitrate of Soda given two weeks later."

SUGGESTIONS FOR CORN GROWING.

SOIL.

One of the first essentials for a good crop of corn is a well-drained soil. This is as important as the fertility. The notion that soil inclined to be wet in the spring will supply more moisture to a growing crop during a drought later in the season is erroneous; the contrary being true. One of the main provisions the corn plant has for protection against dought, is the depth to which it sends some of its roots into the soil; often going down four or five feet, unless prevented from doing so by the presence of free water near the surface. An excess of water excludes the air, which is as important below the surface as above the ground for the proper development of the plant, and later when drought occurs the roots are not in position to draw on the moisture from below. The so-called "drowning out" of corn is due to the exclusion of air, rather than the effect of the water on the roots.

SEED BED.

The seed bed is the first important step in preparing land for a big crop of corn. No amount of working after the crop is planted, can make up for poor preparation at the beginning. The seed must have a firm, yet mellow, moist, warm and well ventilated soil in order to germinate well and grow rapidly. Proper plowing and liberal use of the disc, harrow and roller after plowing, are the only agents which will bring about this condition.

Where crimson and other clover crops do not prevent, the earlier the land is plowed in the spring the better; and if a sod is turned over, fall plowing is still better. In plowing under crimson clover or another green manuring crop, the mistake should not be made of allowing the crop to grow late in the spring until it gets woody; too much rank herbage may dry out the soil that season by interfering with capillarity. As a rule the earlier the crop is plowed under, the more moisture in the soil to cause rapid decomposition.

On the other hand, if the maximum amount of fertility is to be secured for future crops as well as for immediate results; the crop must be allowed to grow as long as possible, and still leave plenty of time to prepare the seed bed properly and plant the crop in good season. On the average, the best time for plowing under crimson and red clover is when the first blooms begin to appear. When a heavy growth of clover or another crop is plowed under, and heavy rains do not follow immediately to pack and unite the furrow slice with the soil below and re-establish capillary action, there is considerable danger that the heavy coat of vegetation will act as a blanket, preventing the moisture below from rising higher than the bottom of the furrow; and thus cause poor germination, and poor growth after the corn comes up. Deep, thorough discing, rolling and harrowing will overcome this difficulty.

PLANTING.

Extensive investigations show that there is practically no difference in yield whether corn is planted in hills (checked) or in drills, providing it is distributed correctly and the same number of stalks per acre are produced. Checked corn is much easier kept free from weeds, requires less hoeing, and under most conditions where the land is not too hilly this method of planting is the most satisfactory. On very hilly fields planting in drills is in most cases the better.

The depth of planting, necessarily depends upon the condition of the seed bed, the soil and weather. It has to do only with the plant getting properly started and in this way may have some bearing on yield. The depth of roots is not materially affected by the depth of planting. On stiff clay soil, with a properly prepared seed bed and normal weather, corn should not be planted over two inches deep, and if the season is wet, planting one to one-half inches deep is better. On the other hand, if the weather is dry and the seed bed poorly prepared better germination will be secured by planting over two inches deep. Deeper planting is also necessary in light loamy or sandy soils.

Planting should not begin until the soil has warmed up to a temperature of about 60 degrees F. So much, however, depends upon the weather before and after planting, and also upon the character of the seed bed, that no definite rule can be given. Investigations have shown little beyond that the old Indian sign, which is, "plant corn when the leaves of oak trees are as large as squirrels' ears," is not much at fault.

The number of stalks per hill or the distance apart in the row if planted in drills depends largely upon the variety, the season and the fertility of the soil. If an exceptionally high yield is desired, and the fertility is provided for, the planting must be thicker than the common practice of planting two stalks in the hill, three feet nine inches by three feet nine inches; for when planted in such a manner with no stalks missing at harvest time and each stalk bearing one ear weighing eight-tenths of a pound (the average weight of ears for a good crop) the yield would be only 70 bushels per acre. On the other hand, if the supply of moisture during July and August should be far below that required, then thicker planting would reduce the yield. The following table shows what may be expected in yield at different rates of planting, provided there is sufficient fertility and moisture to produce a good crop:

What An Acre of Corn Would Produce If There Were No Missing Plants and if Every Stalk Bore One Ear.

Distance apart of hill.	No. hills per acre.	No. stalks in hill.	No. stalks per acre.	Yield of corn per acre in bushels	
				when Ave. wt. of ear is 8-10 lbs.	when Ave. wt. of ear is 1 lb.
3′9″x3 9″	3097	2	6194	70	88
3′9″x3′9″	3097	3	9291	106	132
3′6″x3′6″	3555	2	7110	81	101
3′6″x3′6″	3555	3	10665	122	152
3′9″x3′6″	3318	2	6636	76	95
3′9″x3′6″	3318	3	9954	114	147
3′9″x3′	3872	2	7744	89	111
3′9″x3′	3872	3	11616	133	166
3′9″x20″	6997	1	6997	80	100
3′9″x18″	7744	1	7744	89	111
3′9″x16″	8712	1	8712	100	125
3′9″x14″	9956	1	9956	114	147
3′9″x12″	11617	1	11617	133	166
3′9″x10″	13939	1	13939	159	199
3′9″x 8″	17424	1	17424	199	249
3′6″x20″	7467	1	7467	85	106
3′6″x18″	8250	1	8250	94	117
3′6″x16″	9335	1	9335	107	134
3′6″x14″	10669	1	10669	122	152
3′6″x12″	12446	1	12446	143	179
3′6″x10″	14934	1	14934	171	214
3′6″x 8″	18671	1	18671	213	267

CULTIVATION.

Cultivation should be thorough; it should begin early, and when necessary continue until after the tassel or even the ear appears. No rule can be given for the number of times corn should be worked; because, in some cases four times may be sufficient, and in other cases eight or ten workings may not be too much; weather, weeds, and soil conditions are the only guides.

If, after planting and before the plants have pushed through the ground, heavy rains form a hard crust, the field should be gone over with a spike-tooth harrow or weeder.

This is also an excellent treatment after the corn is up and even after reaching a height of three inches, or more. Care, however, must be taken that the harrowing is done when the soil is in proper condition; little good and often injury resulting when land is too wet or too dry.

The cultivator should be started as soon as conditions will permit, not waiting until weeds show up. The best way to keep the weeds in check is never to let them get started, and the nearer each working is done at the proper time the fewer will be the number of cultivations necessary. Shallow cultivation is preferable at all times; if, however, the ground is hard, or compact and weedy the first cultivation should be deep and close to the corn; but when the plants have reached a height of six or eight inches the cultivations should be shallow, running the shovels not more than three inches deep. After this period of growth the lateral roots spread rapidly in every direction, soon ramifying through all the soil between the rows and the plants. Under normal conditions a large portion of the roots develop near the surface so that cultivating four inches deep may destroy 50 per cent. more roots than three inches deep.

It must be borne in mind that the destruction of weeds is not the only reason for cultivating, breaking a hard crust to allow the air to penetrate the soil, and to conserve the moisture is often equally as important as killing weeds.

SEED.

It is a mistake to go far away from home for seed corn if a heavy yield the first season is the main object. Seed brought in from a long distance and grown under different climatic conditions will not, as a rule, yield as well the first year or two as *good seed* of a good variety grown near-by. Usually the larger growing and later maturing varieties will yield more than the earlier and smaller growing sorts. Care however, must be taken that the variety is not too late in maturing and that the cob is not too large or a high percentage of rotten corn, and consequently a material reduction in yield is sure to follow. High germination is always necessary for a large yield and the only way to insure this is to test each ear for germination and discard all those which do not come up to the standard. For methods of testing see Bulletin No. 141 of this Station.

FERTILIZER.

Stable or barn-yard manure is by far the best fertilizer for corn, but even this cannot make up in one year all the deficiencies of poor soil, and if an exceptionally high yield at a minimum cost of production is desired, the soil must be fertile to start with. Experiments at this Station show that fresh manure applied in the fall or early winter and plowed under in the spring gives better yields of corn than when applied the latter part of the winter or spring. Rotted manure applied in the spring gave better results than fresh manure.

As a rule, commercial fertilizer when applied alone to corn gives less profit than when applied to other crops. Much, however, depends upon the weather and composition of the fertilizer. In a dry season heavy applications of commercial fertilizer may reduce the yield but in a wet year bad results seldom occur and often profitable returns are secured. At this Station the best results have been secured when the fertilizer was used in combination with stable manure, especially was this true when Kainit was used with the manure. Other investigations show that a complete fertilizer when applied to corn usually gives the best results. Among the complete fertilizers those high in nitrogen give the highest yields, and in a dry season are least apt to cause "firing."

Suggestions for Boys' Corn-Growing Contests.

The contest should be limited to boys under 18 years of age. Awards should be made for the most air-dry shelled corn grown on one acre of land at the greatest net profit.

Each boy entering the contest should be required first to make an agreement with his father or guardian by which he will receive the net proceeds of the acre of corn grown by him whether he wins a prize or not.

Each boy entering the contest should send his name, address, age, and his father's name to those in charge of the contest not later than May 15th of the year in which the corn is to be grown.

The boys should be required to at least work the land before planting, plant the corn and cultivate the crop. The acre may be a part of a field or it may be a separate field. On account of the damage usually done in turning while cultivating, if the acre is a separate field, it should contain a little more than an acre to allow at least one extra border row on all sides which must be discarded at the time of harvesting.

Each contestant should be required to keep an accurate account of the kind, amount and cost of commercial fertilizer and lime applied, and if manure is used the number of two-horse loads. In addition to this he should be required to give an account of the crops grown on the land the preceding three years. He must also keep a careful record of the time and manner of plowing the land, the date and number of harrowings and other workings given the soil before planting the corn and the time and manner of applying the commercial fertilizer or barnyard manure. After the corn is planted he must record every step taken in the process of growing the corn and keep an accurate account of the amount of team and man labor.

Before harvesting the crop the land should be measured and the number of stalks and ears on the acre counted by some one in charge. Arrangements should also be made for weighing the crop after husking, and determining the average weight per ear, which may be done by weighing and counting the number of ears in ten or more baskets as they come from the pile. The object is for detecting fraud.

At the time of weighing a sample of at least fifty pounds of average ears should be sent to the Maryland Agricultural Experiment Station, College Park, where the percentages of moisture and of shelled corn necessary, for calculating the yield of air-dry shelled corn, will be determined. In the sample should be placed a card giving the exact weight of the sample at the time of weighing and the boy's name and address.

In determining the standing of the contestants, both yield and net profit should be considered, allowing 60 points for yield and 40 points for net profit. Net profit is the difference between the total value of the grain and total cost of production. In calculating net profit the corn should be given a uniform value per bushel; fertilizer should be valued at cost, and lime at one-fourth cost, but for all other expenses a uniform charge should be made.

To facilitate and simplify the work a record sheet as given in this bulletin should be sent to each boy to be filled out by him and sent to those in charge of the contest immediately after his crop is weighed.

When desired the station will make all necessary calculations if furnished the measurements of the acre, the total weight of corn, the average weight per ear, and the record sheet.

RECORD SHEET.

Name .... Age..............

County .... Post-Office ....

If the corn is checked give distance apart of hills........................

How many stalks to the hill?...

If the corn is drilled give distance apart of rows and distance between stalks in row...

How many stalks on the acre?...

How much commercial fertilizer was used on the acre?..................

When was fertilizer applied?..

Kinds? .... Analysis?.....................

Price per ton?..

How much lime?...................... Price per ton....................

How many two-horse loads of manure?.....................................

What was grown on the land during the preceding three years?.............

....

When was the land plowed for corn?.......................................

Give date, time required and implement used for each operation in preparing the land for planting...

....

....

Give date of planting...

How many times was the corn cultivated?..................................

Date of each cultivation..

SUMMARY OF WORK DONE ON ACRE.

	Total No. Hrs. of Man Labor.	*Total No. Hrs. of Team Labor.
Plowing the land		
Preparing the land for planting		
Sowing on fertilizer		
Planting		
Cultivating		
Thinning		
Hoeing		
Replanting		
Cutting		
Husking		
Totals		

*Number of hours required for a team of two horses.

The cost of labor is not to be supplied by the boy but a uniform price will be adopted by the committee in charge.

Note—Copies of this Record Sheet may be secured by writing to the Maryland Agricultural Experiment Station, College Park, Md.

THE MARYLAND AGRICULTURAL
EXPERIMENT STATION.

BULLETIN No. 166. MAY, 1912.

HOW LIME IS DISTRIBUTED THROUGH AND LOST FROM SOILS.

FACTORS INFLUENCING THE DIFFUSION AND DEPLETION OF LIME IN SOILS.

By L. B. Broughton.

Introduction.

This bulletin gives the results of some investigations which were conducted with a view of determining the rapidity with which lime is diffused or distributed through the soil and the factors which influence its distribution. Investigations were also conducted to determine the factors which cause lime to be removed or lost from the soil.

The work reported on in this paper was begun at the suggestion of Director H. J. Patterson in order to make a more thorough study of the results of the effects of lime presented in Bulletin 110, of this Station. In that bulletin experiments were reported on showing the increase in yield of different crops as the result of the application to the soil of different salts of calcium (lime) together with experiments showing the lasting qualities of lime in regard to increased crop production. A study was made of the effect of different kinds of lime and different modes of applying the same; also tests were made to determine if the soil was deficient in lime as a plant food or only responding to chemical and physical changes brought about by the addition of an alkali to the soil.

Object of Experiment.

The aim of the investigation reported in the following pages is to show the amount of the different limes removed from the soil by the drainage water and the rate of the movement of the same through the soil, together with the amount of lime (CaO) removed from the soil by crops, and the effect of carbondioxide on the solubility of the different limes used; also the action of the same on the movement of calcium oxide through the soil. Thus the meaning of diffusion and depletion in this sense, is the rate of movement of the lime from the upper six inches through the second and third six inches and out into the drainage water.

The movement of the lime in the soil is thus determined by two agencies, partly by the diffusibility of the salt in water and partly by the actual movement of the water within the soil. The greater movements are occasioned by the latter cause, but the influence of the former is by no means insignificant.

Pots Used for Experiment.

The experiment was carried on in large stone pots, glazed inside and outside, having an outlet one-half inch in diameter, on the side, one-half inch from the bottom. All pots used were of uniform type, each being 13 inches in diameter and 16 inches high and having an inside capacity of 2831 cubic inches. In all there were 28 pots used, nineteen being placed under artificial conditions and nine subject to natural conditions as follows:

Pots	1, 2, 3,	Sand, Clay, Loam, resp., treated with	Com. Oxide of Lime.
“	4, 5, 6,	“ “ “ “ “ “	“ Carbonate of Lime (Lime Stone.)
“	7, 8, 9,	“ “ “ “ “ “	“ Phos. of Lime.
“	10, 11,	“ “ “ “ “ “	“ Carbonate of Lime (Oyster Shells.)
“	12, 13,	“ “ “ “ “ “	“ Sulphate of Lime (Gypsum.)
“	14, 15,	“ “ “ “ “ “	“ Mag. Carbonate.
“	16, 17,	“ “ “ “ “ “	“ Barium Hydrate.
“	18, 19,	“ “ “ “ “ “	“ C. P. Cal. Oxide.

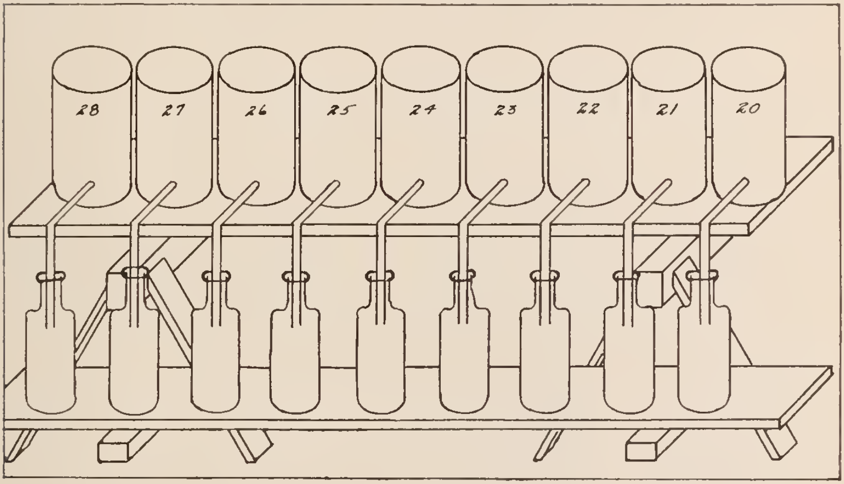
Pots 20, 21, 22, 23, 24, 25, 26, 27 and 28, sand, clay and loam, respectively, were treated with Commercial Oxide, Carbonate, and Phosphate of Lime, and subject to outside or natural conditions.

The pots under artificial conditions were placed in a green house thirty feet long by ten feet wide and ten feet high, at the comb of the roof. The roof slanted from a four foot brick wall on each side to the center of the house. The pots were placed on each side of the house 4 feet from the ground, the tops of which were only 6 inches from the lower edge of the glass roof.

In setting up the outside pots a space between two greenhouses was selected. The space was shut in on three sides by glass houses so that the pots were protected from the high winds but exposed to the weather, and were not shaded at any time throughout the day.

The drawing on the following page shows the method of placing the pots under both natural and artificial conditions, each pot being a separate experiment in itself.

As shown in the figure each pot has an outlet on the lower side in which is tightly fitted a glass tube by means of a rubber stopper. Each tube is so bent that the end comes down and fits into the neck of a two liter bottle, thus making it possible to catch all drainage water that percolated through the soil in the pot. By the above method each pot was so placed that the drainage was obtained by gravity alone, the percolation being in no way forced. The soil was in no way loosened, except when samples were drawn, and then precautions were taken to fill in the hole made by the sampling tube.



Soils Used.

Three types of soils, namely, sand, clay and loam, were used for the study, classified by the Bureau of Soils, U. S. Department of Agriculture, as Norfolk sand, Susquehanna clay and Sassafras sandy loam.

The sandy soil was gotten on a farm near College Park, Maryland, and presents a typical light, sandy soil, as classified as Norfolk sand. The soil had been under cultivation for a number of years, the principal crops being trucks.

The clay soil was gotten on the Experiment Station farm and furnished a good type of the Susquehanna clay. This soil had not been under cultivation for a number of years, being used in the main as a pasture, for the Station herd.

The surface of the soil was well matted with sod, the roots of which extended to a depth of from two or three inches.

The loam, a dark, sandy soil classified as Sassafras sandy loam, was gotten from the garden of the Experiment Station, and had been under cultivation for a great many years in garden crops. Though fertilizer had been added from time to time the soil as a whole always gave a good crop, and can be spoken of as being a very fertile soil.

In considering the three soils under observation it can be said that each presents a good type of the sand, clay and loam, and each afforded a good basis for the study reported on.

No lime had been added to the soil to the best of knowledge for a period of ten years, and each gave a decided reaction with Veitch's method for soil acidity.

CHEMICAL ANALYSIS OF SOILS.

Table No. 1 gives the chemical composition of average samples of the soils at three depths of six inches each. The method of analysis followed was that advocated by the Association of Official Agricultural Chemists. An examination of the table will show that we have here soils, like those classified as Norfolk sand, Susquehanna clay and Sassafras sandy loam. The most important consideration, however, for the purpose of this investigation is the fact that the calcium content of each soil is exceptionally low.

TABLE No. 1.

Chemical Analysis of Soils.

	Sand			Clay			Loam		
	1st 6 in.	2nd 6 in.	3rd 6 in.	1st 6 in.	2nd 6 in.	3rd 6 in.	1st 6 in.	2nd 6 in.	3rd 6 in.
Insoluble Matter	94.14	94.00	96.25	80.33	72.34	72.84	86.80	88.44	87.79
Potash (K_2O)	.95	60	.55	2.16	1.35	1.47	1.82	1.17	99
Soda (Na_2O)	.80	.65	.60	2.95	2.15	2.16	1.88	1.50	1.30
Lime (CaO)	.19	.18	.10	.15	.16	.11	.15	.12	.13
Magnesia (MgO)	.25	.30	.14	.45	.30	.30	50	.35	.25
Manganese (Mn_2O_3)	.07	.00	.00	.15	.08	.05	.30	.22	.10
Iron and Aluminum . ..	1.00	1.30	1.40	6.95	12.50	13.60	3 55	4.00	5 10
Phos. Pentoxide (P_2O_5) .	.06	.07	.09	.19	.31	.30	.14	.12	.12
Sulphur Trioxide (SO_3) .	.01	.01	.02	.02	03	.02	.02	.02	.02
Volatile matter.........	1.40	1.15	.63	7.44	5.84	5.59	3.60	2.62	2.67
Total	......	......	......	......	......	......	.....	......	......
Humus.................	.15	.....	......	1.10	......	......	1 95	.. .	......
Ash....................	98.35	98 60	98.65	88 35	85 40	87.15	92.20	92 90	92 75
Nitrogen...............	.07	.03	.03	.12	.06	.06	.13	.08	.04
Moisture	.25	.25	.72	6.70	9.25	7.40	4.35	4.60	4.70

PHYSICAL COMPOSITION OF SOILS.

Table No. 2 gives the physical composition of the soils at the three depths. The results show the soils to be very characteristic of the three classifications.

ACIDITY OF SOILS.

Table No. 3 gives the lime (CaO) required to neutralize the acidity of the first six inches of the soils by the Veitch method. The results show exceptionally high acidity in respect to the clay and loam soils.

TABLE No. 2.

Mechanical Analysis of Soils.

		Sand			Clay			Loam		
		1st 6 in. %	2nd 6 in. %	3rd 6 in. %	1st 6 in. %	2nd 6 in. %	3rd 6 in. %	1st 6 in. %	2nd 6 in. %	3rd 6 in. %
Gravel............	2.0	7.28	27.00	66.27	3.73	10.63	11.21	1.42	.24	.42
Coarse Sand......	1.0	1.40	1.54	1.39	1.15	1.50	1.27	2.10	1.64	1.79
Medium Sand.....	.5	24.34	22.62	10.69	3.00	5.39	3.00	15.38	16.36	20.20
Fine Sand........	.25	48.31	34.76	15.02	.96	5.02	1.69	68.29	59.42	50.61
Very Fine Sand...	.10	9.06	4.89	2.56	18.81	11.45	8.63	9.16	17.02	21.63
Silt and Clay....	.00	9.38	8.30	3.23	70.72	60.66	69.00	1.37	3.93	3.09
Total.	.00	99.77	99.12	99.16	98.37	94.62	94.80	97.74	99.63	97.76

TABLE No. 3.

Lime Requirements.

Soil.	lbs. per acre.	bus. per acre.
Sand. Lime required to neutralize acidity................	1045	13.06
Clay. Lime required to neutralize acidity................	3036	37.95
Loam. Lime required to neutralize acidity................	3659	45.67

In taking the soil from the field, a trench 18 feet long by 1 foot wide and 18 inches deep was laid off, the surface being cleared of all foreign matter and sod. The first 6 inches was taken off and bagged, as were the second and third, each division being kept separate. Each division was well mixed and 14,700 grams were weighed out, representing approximately 700 cubic inches of earth, and placed in the pots in regular order, that is, 14,700 grams of the third 6 inches, 14,700 grams of the second 6 inches and 14,700 grams of the first 6 inches, making a total of 44,100 grams to each pot. The first six inches of each pot was well mixed with the lime to be added. Thus the soil was so placed in the pots that field conditions were well represented, and *each of the three depths placed in regular order.*

Alkalies Used.

For the investigation the alkalies used in the study reported on in Bulletin 110 of this institution were selected, namely: commercial calcium oxide [(CaO) (burnt stone lime)], calcium carbonate [($CaCO_3$) (finely ground lime stone], calcium phosphate [Ca_3 $(PO_4)_2$], calcium carbonate [(Ca CO_3) (powdered oyster shells)], calcium sulphate [($CaSO_4$) (gypsum or land plaster)], magnesium carbonate [$MgCO_3$], barium hydrate [$Ba(OH)_2$], and C. P. calcium oxide [CaO].

The commercial calcium oxide of lime, known as lump lime, is ordinary burnt limestone, such as obtained on the market for building purposes. Calcium carbonate (lime stone), calcium carbonate (oyster shells), calcium sulphate (gypsum) and magnesium carbonate are all the raw rock finely ground or powdered. The barium hydrate is a commercial chemical product, whereas the C. P. oxide of calcium is such as is obtained as chemically pure calcium oxide.

Each of the above-named alkalies has been quite extensively used in imrpoving the soil for agricultural purposes and as a general rule they all aid materially in increasing crop production.

Chemical Analyses of Alkalies.

Table No. 4 gives the analyses of the alkalies used, showing the total per cent. of oxide of each salt.

TABLE No. 4.

Chemical Analyses of Alkalies.

	CaO	Lime Stone $CaCO_3$	Oyster Shells $CaCO_3$	$Ca_3(PO_4)_2$	Gypsum $CaSO_4$	C. P. CaO	$MgCO_3$	Ba (OH)$_2$
Insoluble Matter.........	2.04	1.47	10.20	9.80	2 22	.....	1 88	......
Calcium Oxide (CaO)....	70.99	53 44	47 50	13.74	38.37	78.48	......	....
Cal. Carbonate ($CaCO_3$)..	......	95.37	84.86	......	......	......	2.98	......
Mag. Oxide (MgO)........	.24	.73	.59	......	.10	......	35.53	......
Mag. Carbonate ($MgCO_3$)	......	1 55	1.47	......	.....	......	74.27	......
Iron and Aluminum Oxides	1.20	1.75	1.87	37.77	1.20	......	.48	......
Barium Oxide (BaO).....	......	......	......	......	......	......	....	49.04
Barium Hydrate Ba(OH_2)	......	......	......	......	......	......	......	54.65
Phosphoric Acid (P_2O_5)...	......	......	......	32.83	1.26	......	.. ...	......
Sulphur Trioxide (SO_3)...	......	......	......	.....	32.85	......	......	......

Mechanical Analyses of Alkalies.

Table No. 5 shows the degree of fineness of the ground limestone, oyster shells and phosphate rock, as they were obtained on the market and used in the experiment. The weights as reported in the table is the amount larger than the mesh of the sieve, being that portion that remained in the sieve after shaking the nest for 30 minutes.

TABLE No. 5.

Mechanical Analyses of Limes.

(Percent that pass through sieves of different meshes.)

Size of Mesh	2 mm*	1 mm	.5 mm	.25 mm	.10 mm	.05 mm	Total
Ground Limestone.........	.110	.325	7.390	14.510	47.190	30.450	99.97
Ground Oyster Shells......	.120	8.210	38.290	41.800	9.120	2.440	99.98
Ground Phosphate Rock...	.265	.120	1.450	39.810	40.910	17.330	99.88

*—1 sq. mm=.0015 sq. in.

ALKALI ADDED TO EACH POT.

Owing to the fact that there was such a large amount of lime needed to correct the acidity in the clay and loam soil (Table No. 3), and the difference between these two and the sand soil, it was determined to lime each soil at the same rate, using enough to correct the acidity in the first six inches of the loam soil; thus as determined each pot was limed at the rate of 4,000 pounds of pure calcium oxide to the acre, making 33.39 grams of the oxide added to each pot.

All the alkalies were added on oxide basis, the percentage of the same calculated from the analysis in Table No. 4.

The following table shows the amount of the alkali added to each pot, together with the weight of the oxide held by it:

TABLE No. 6.

Amount of Alkali Added to Each Pot.

Pot No.	Soil.		Grams of Alkali.	Grams of Oxide.
		Artificial Conditions.		
1	Sand.	Com. oxide of lime	46.90	33.39
2	Clay.	Com. oxide of lime	46.90	33.39
3	Loam.	Com. oxide of lime	46.90	33.39
4	Sand.	Com. carbonate of lime	62.47	33.39
5	Clay.	Com. carbonate of lime	62.47	33.39
6	Loam.	Com. carbonate of lime	62.47	33.39
7	Sand.	Com. phosphate of lime	243.00	33.39
8	Clay.	Com. phosphate of lime	243.00	33.39
9	Loam.	Com. phosphate of lime	243.00	33.39
10	Sand.	Com. oyster shells	70.29	33.39
11	Clay.	Com. oyster shells	70.29	33.39
12	Sand.	Com. sulphate of lime	87.02	33.39
13	Clay.	Com. sulphate of lime	87.02	33.39
14	Sand.	Com. magnesium carbonate	93.98	33.39
15	Clay.	Com. magnesium carbonate	93.98	33.39
16	Sand.	Com. barium hydrate	68.08	33.39
17	Clay.	Com. barium hydrate	68.08	33.39
18	Sand.	Com. C. P. calcium oxide	42.54	33.39
19	Clay.	Com. C. P. calcium oxide	42.54	33.39
		Natural Conditions.		
20	Sand.	Com. oxide of lime	46.90	33.39
21	Clay.	Com. oxide of lime	46.90	33.39
22	Loam.	Com. oxide of lime	46.90	33.39
23	Sand.	Com. carbonate of lime	62.47	33.39
24	Clay.	Com. carbonate of lime	62.47	33.39
25	Loam.	Com. carbonate of lime	62.47	33.39
26	Sand.	Com. phosphate of lime	243.00	33.39
27	Clay.	Com. phosphate of lime	243.00	33.39
28	Loam.	Com. phosphate of lime	243.00	33.39

AMOUNT OF WATER EACH POT RECEIVED.

In determining the amount of water to be added to the pots under artificial conditions an average rainfall for a number of years was taken, so as to have conditions as near as possible as they are at this Station from year to year.

In making the average the records for nine years at this Station were taken as follows:

TABLE No. 7.

Year 1901	Total rainfall for year	49.42 inches.
Year 1900	Total rainfall for year	37.50 inches.
Year 1899	Total rainfall for year	45.80 inches.
Year 1898	Total rainfall for year	35.24 inches.
Year 1897	Total rainfall for year	46.34 inches.
Year 1896	Total rainfall for year	30.37 inches.
Year 1895	Total rainfall for year	35.54 inches.
Year 1894	Total rainfall for year	33.20 inches.
Year 1893	Total rainfall for year	36.22 inches.
Average for nine years		38.83 inches.

Thus each pot under artificial conditions received 38.83 inches, making a total of 5151.97 cubic inches or 84.425 liters of distilled water.

In adding the water to the pots from day to day the rainfall received for the year 1900 was followed as closely as possible, the number of inches received for this year being very near the average for the nine years.

The outside pots were exposed to natural rainfall throughout the year from December 1st, 1909, to November 10, 1910, each pot receiving as a total 35.91 inches, amounting to 4765.97 cubic inches or 78.114 litres of rain water.

In the following tables, No. 8 and No. 9, is given the calendar for the year of the pots under both conditions, the inches of water received by the pots from time to time being recorded as cubic centimeters.

TABLE No. 8.

Rainfall For Pots Under Artificial Conditions.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	-----	-----	-----	-----	-----	-----	-----	246	-----	-----	-----	-----
2	-----	-----	-----	-----	-----	-----	-----	246	-----	-----	1000	-----
3	-----	-----	-----	-----	-----	-----	-----	246	-----	-----	-----	2000
4	-----	-----	-----	1000	-----	-----	-----	246	-----	380	-----	-----
5	-----	-----	-----	-----	3000	-----	-----	246	1000	-----	-----	-----
6	-----	-----	4000	-----	-----	-----	2000	246	-----	-----	2380	-----
7	-----	-----	-----	-----	-----	-----	2000	246	-----	2000	-----	-----
8	-----	-----	-----	1380	-----	-----	-----	246	-----	-----	-----	-----
9	-----	-----	-----	-----	1000	-----	500	246	2000	-----	-----	2000
10	2000	-----	-----	-----	-----	-----	500	246	-----	-----	-----	-----
11	-----	-----	1380	-----	-----	-----	500	246	-----	2000	-----	-----
12	-----	-----	-----	-----	-----	-----	500	246	-----	-----	3000	-----
13	1000	-----	-----	2000	1000	-----	500	246	2000	-----	-----	-----
14	380	-----	-----	-----	-----	-----	500	246	-----	-----	-----	-----
15	-----	2000	2000	-----	-----	-----	-----	246	-----	-----	-----	-----
16	-----	-----	-----	1000	-----	-----	1760	-----	-----	2000	-----	-----
17	-----	-----	-----	-----	-----	-----	-----	492	-----	-----	465	-----
18	2000	-----	1000	-----	-----	-----	-----	-----	1000	-----	-----	-----
19	-----	-----	-----	500	-----	-----	2000	492	-----	-----	-----	-----
20	-----	-----	1000	500	-----	-----	-----	-----	-----	-----	-----	-----
21	-----	-----	-----	-----	-----	-----	3000	492	1000	-----	-----	-----
22	1000	-----	-----	-----	-----	-----	-----	-----	-----	1000	-----	-----
23	-----	-----	-----	-----	-----	1000	-----	492	-----	-----	1000	-----
24	-----	2000	-----	-----	-----	1000	-----	-----	380	-----	-----	-----
25	-----	-----	1000	-----	-----	500	-----	-----	-----	-----	-----	-----
26	-----	-----	-----	500	-----	-----	-----	-----	-----	-----	-----	-----
27	-----	-----	-----	500	-----	-----	-----	1762	-----	-----	-----	-----
28	1000	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
29	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
30	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
31	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

TABLE No. 9.

Rainfall For Pots Under Natural Conditions.

Day	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	-----	-----	-----	1955	-----	-----	-----	-----	-----	674	-----	-----
2	-----	-----	3182	-----	-----	-----	Tr.	412	-----	-----	-----	Tr.
3	-----	-----	-----	-----	217	-----	564	-----	-----	282	-----	1130
4	-----	-----	-----	-----	564	651	-----	-----	153	-----	-----	2713
5	-----	-----	-----	-----	-----	-----	1891	-----	-----	-----	-----	-----
6	-----	-----	-----	-----	-----	-----	-----	-----	-----	890	-----	-----
7	-----	-----	-----	-----	152	-----	217	-----	-----	-----	1131	-----
8	-----	-----	-----	-----	-----	-----	-----	-----	651	-----	759	-----
9	-----	-----	-----	-----	-----	976	1191	-----	434	-----	608	-----
10	-----	-----	174	260	-----	-----	911	-----	87	-----	-----	Tr.
11	-----	-----	-----	325	-----	282	412	-----	805	-----	-----	-----
12	-----	-----	-----	-----	-----	1151	2214	998	-----	-----	-----	-----
13	2714	-----	-----	-----	-----	-----	108	391	-----	-----	-----	-----
14	1216	-----	-----	-----	-----	-----	-----	-----	-----	174	-----	-----
15	-----	2760	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
16	-----	-----	-----	-----	-----	-----	434	-----	978	-----	-----	-----
17	-----	-----	-----	-----	4561	-----	477	-----	157	-----	-----	-----
18	-----	-----	868	-----	2216	456	-----	-----	Tr.	-----	-----	-----
19	-----	-----	-----	-----	477	-----	-----	912	22	-----	Tr.	-----
20	-----	-----	-----	-----	217	Tr.	-----	-----	-----	-----	4709	-----
21	-----	1080	1371	-----	465	1891	-----	-----	22	-----	-----	-----
22	-----	-----	260	-----	629	716	-----	-----	-----	-----	1649	-----
23	-----	-----	-----	-----	347	-----	-----	-----	-----	-----	-----	-----
24	-----	-----	-----	-----	2432	-----	-----	-----	-----	-----	-----	-----
25	-----	-----	-----	-----	1151	1678	-----	-----	-----	-----	44	-----
26	1679	-----	-----	-----	282	587	-----	-----	652	-----	-----	-----
27	-----	-----	-----	-----	-----	-----	1193	-----	-----	-----	Tr.	-----
28	-----	-----	-----	-----	-----	-----	-----	543	-----	-----	282	-----
29	-----	-----	-----	-----	-----	-----	-----	-----	Tr.	-----	-----	-----
30	-----	5840	-----	-----	-----	217	-----	239	-----	-----	-----	-----
31	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Temperature Conditions During Time of Experiment.

The temperature of the greenhouse was kept as near constant as possible during the cold months of the year, the temperature ranging around 65 degrees F. for a greater part of the time. In a few instances the temperature dropped to 40 degrees F. during the course of the night, and on three occasions the temperature rose to 80 degrees F. during the warmer part of the day. These conditions were kept through December, January, February and March, covering the first two periods. Through April, May, June, July, August and September, covering periods three to five, the temperature ranged from 55 degrees F. to 110 degrees F., whereas through the latter part of September, October and November the temperature fell back to a constant around 65 degrees F. Thus the pots under artificial conditions were subject to a temperature for:

December	from	40	degrees	F.	to	80	degrees	F.
January	“	40	“	“	“	80	“	“
February	“	40	“	“	“	80	“	“
March	“	40	“	“	“	80	“	“
April	“	55	“	“	“	90	“	“
May	“	65	“	“	“	100	“	“
June	“	65	“	“	“	100	“	“
July	“	85	“	“	“	110	“	“
August	“	85	“	“	“	110	“	“
September	“	65-50	“	“	“	100-90	“	“
October	“	40	“	“	“	80	“	“
November	“	40	“	“	“	80	“	“

At no time during the year did the temperature drop to the freezing point, the lowest temperature recorded being 40 degrees F. Thus the two extremes for the year were 40 and 110 degrees F. for the cold and hot months of the year.

The outside pots were exposed to a greater variation of temperature than were the pots placed in the greenhouse, being subject to extremes of hot and cold during the entire year. In January of 1910 the pots were frozen, thus making it impossible to take samples at the end of the first period. The temperature varied considerably from day to day, the maximum and minimum points recorded being 10 degrees F. and 105 degrees F., the range of temperature for the cold months being 10 to 50 degrees, and for the hot months from 65 to 105 degrees.

Time and Method of Taking Samples.

The conditions at the time of sampling were all very favorable with exceptions of the first period as mentioned above, where samples could not be obtained from the outside pots on account of being frozen. As a whole samples were obtained very successfully from both the soils and drainage water, and in no case was there any of the latter lost, though there was a great amount of trouble caused by the water freezing before it could be taken in from the outside pots.

The experiment was divided into six periods, one of thirty and five of sixty days, as follows:

First Period—December 10, 1909, to January 10, 1910.
Second Period—January 10, 1910, to March 10, 1910.
Third Period—March 10, 1910, to May 10, 1910.
Fourth Period—May 10, 1910, to July 10, 1910.
Fifth Period—July 10, 1910, to September 10, 1910.
Sixth Period—September 10, 1910, to November 10, 1910.

Samples were taken of the soil and drainage water at the end of each period, and analysis made for the per cent. of calcium oxide.

In taking the samples from the pots a soil sampling tube one inch in diameter was used, the tube being pushed down in the pot until the bottom was reached and drawn out carefully so as not to cause any disturbance in the different layers. After the tube was drawn the soil was worked from the sides until the hole was closed where the tube had been inserted, and then the pot jostled slightly so the soil would pack in at the sides. The tube containing the sample of soil was then taken and three equal portions measured off representing the three layers of the pot, bottled and taken to the laboratory for analysis.

In taking samples of the drainage water the total amount of water percolating through during the period was accurately measured, well mixed and one-fifth of the total amount used for the sample.

Method of Analysis.

In making the analysis of the soil, the samples as taken from the pots were placed in moisture pans and dried at 100 degrees centigrade for eight hours. Then the sample of moisture free soil was rubbed up with a rubber covered pestle and passed through a 1 mm. sieve, the fine earth being preserved in bottles for analysis.

For the calcium determination 10 grams of the fine earth were weighed out and digested for 10 hours in 100cc. of strong hydrochloric acid (1.115) in an Erlenmeyer flask of 300cc. capacity, fitted with a reflex condenser. The acid extract filtered and calcium oxide determined in the filtrate by ammonium oxalate method.

For the estimation of the calcium in the drainage water one-fifth of the amount that percolated through during a period was evaporated to dryness in a porcelain dish, taken up with strong hydrochloric acid (1.115) evaporated down to dryness on a water bath, taken up with hydrochloric acid, filtered, made up to definite volume, an aliquot portion taken and calcium oxide determined by the ammonium oxalate method.

Results of the Experiment.

In the following tables showing the results of the experiment, the pots containing the sand, clay and loam soils are all grouped in separate tables. Thus Tables No. 10 and No. 11 show the results obtained on the sand soil; tables No. 12 and No. 13, the results on the clay soil, and tables No. 14 and No. 15 the results on the loam soil.

Tables Nos. 10, 12 and 14 give the weight of lime added to each pot and the amount of water received for each period, together with the amount of water percolated through during each period and the weight of the oxide dissolved in same. The summary of the results at the bottom of the table shows the total amount of water added for the

TABLE No. 10.

Results Obtained on Sand Soil.

	Pot No.	No. 1	No. 4	No. 7	No. 10	No. 12
	Soil Used	Sand	Sand	Sand	Sand	Sand
	Lime Added	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$	Oyster Shells $CaCO_3$	Gypsum $CaSO_4$
Periods	Weight of Lime Added	33.39g	33.39g	33.39g	33.39g	33.39g
First	cc of water added	7380	7380	7380	7380	7380
First	cc of water collected	900	1020	680	1000	400
First	wt. of lime in drainage water	.0740	.1665	.1460	.2080	.5815
Second	cc of water added	16760	16760	16760	16760	16760
Second	cc of water collected	9800	9500	9500	9300	10,850
Second	wt. of lime in drainage water	.1100	.4050	.7160	.7760	5.5975
Third	cc of water added	10000	10000	10000	10000	10000
Third	cc of water collected	5500	8020	6200	5900	6600
Third	wt. of lime in drainage water	.2750	.2412	.4975	.4287	5.3812
Fourth	cc of water added	18700	18700	18700	18700	18700
Fourth	cc of water collected	2700	3500	2300	2300	2000
Fourth	wt. of lime in drainage water	.3825	.3087	.0937	.1400	1.7812
Fifth	cc of water added	14750	14750	14750	14750	14750
Fifth	cc of water collected	2500	3400	1600	1900	2150
Fifth	wt. of lime in drainage water	.5875	.5687	.1500	.1437	1.0250
Sixth	cc of water added	16845	16845	16845	16845	16845
Sixth	cc of water collected	6800	6700	6300	8500	5500
Sixth	wt. of lime in drainage water	1.1500	.9750	.2968	.9092	3.7812
Total cc of water added for year		84425	84425	84425	84425	84425
Total cc of water collected for year		28520	32140	26580	28900	27500
Total wt. of lime recovered in drainage water		2.5790	2.6650	1.8800	2.6056	18.1476
Per cent. of lime lost through drainage		7.72	7.98	5.63	7.80	54.38
Wt. of lime removed per acre		309 lbs.	319 lbs.	225 lbs.	312 lbs.	2177 lbs.

year, the amount of water percolating through the soil and the weight of the respective oxides removed by same for the year. The per cent. depletion as shown is worked out on the basis of the weight of the oxide added. In the last column is shown the weight of the oxide removed from one acre of the soil, calculated from the results in the table.

TABLE No. 10—Continued.

	Pot No.	No. 14	No. 16	No. 18	No. 20	No. 23	No. 26
	Soil Used	Sand	Sand	Sand	Sand	Sand	Sand
	Lime Added	Magn'sium Carbonate $MgCO_3$	Barium Hydrate $Ba(OH)_2$	Lime CaO	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$
Periods	Weight of Lime Added	33.39g	33.39g	33.39g	33.39g	33.39g	33.39g
First	cc of water added	7380	7380	7380	5609	5609	5609
First	cc of water collected	1000	1000	0000	1050	1050	1040
First	wt. of lime in drainage water	.0490	.0000	.0000	.2185	.2365	.2056
Second	cc of water added	16760	16760	16760	17750	17750	17750
Second	cc of water collected	9350	9000	9300	9650	9000	8400
Second	wt. of lime in drainage water	.4665	.0000	.2740	.2750	.2950	.1500
Third	cc of water added	10000	10000	10000	15662	15662	15662
Third	cc of water collected	7700	7530	9640	7550	6780	7630
Third	wt. of lime in drainage water	1.1117	.1340	.4712	.5406	.6906	.5812
Fourth	cc of water added	18700	18700	18700	17002	17002	17002
Fourth	cc of water collected	2520	2850	2450	5400	3500	5450
Fourth	wt. of lime in drainage water	1.0382	.0920	.2718	.3187	.5531	.2600
Fifth	cc of water added	14750	14750	14750	8890	8890	8890
Fifth	cc of water collected	4000	3750	3000	400	1500	450
Fifth	wt. of lime in drainage water	.7925	.1570	.3156	.0493	.2056	.0261
Sixth	cc of water added	16845	16845	16845	13199	13199	13199
Sixth	cc of water collected	7800	6800	8200	5800	4000	6500
Sixth	wt. of lime in drainage water	1.7537	.3400	1.1781	.4625	.3780	.1712
	Total cc water added for year	84425	84425	84425	78114	78114	78114
	Total cc water collected for year	32370	30930	32590	29850	25830	29470
	Total wt. lime recovered in drainage water	5.2116	.7230	2.5707	1.8646	2.3588	1.3935
	Per cent. of lime lost through drainage	15.60	2.16	7.51	6.58	7.06	4.17
	Wt. of lime removed per acre	625 lbs	86 lbs	301 lbs	223 lbs	283 lbs	167 lbs

Tables Nos. 11, 13 and 15 give the analysis before starting the experiment, after the alkalies had been added, showing the per cent. of the oxide in each six inches of soil. The analysis of each period of the first, second and third six inches shows the rate of movement in per cent. of the oxide through the three depths of the pot. The results as summarized at the bottom of the tables show the decrease in per cent. and weight of the oxide in the first six inches, and the increase in per cent. and weight of the oxide in the second and third six inches.

TABLE No. 11.

Analysis of Different Depths of Soil at End of Each Period.

Pot No.	No. 1	No. 4	No. 7	No. 10	No. 12
Kind of Soil	Sand	Sand	Sand	Sand	Sand
Lime	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$	Oyster Shells $CaCO_3$	Gypsum $CaSO_4$
Analysis before starting Expt. 1st 6 in.	.435	.475	.925	.325	.525
Analysis before starting Expt. 2nd 6 in.	.212	.165	.185	.187	.050
Analysis before starting Expt. 3rd 6 in.	.125	.112	.125	.150	.045
Analysis end of first period 1st 6 in.	.425	.475	.900	.300	.475
Analysis end of first period 2nd 6 in.	.210	.165	.200	.200	.100
Analysis end of first period 3rd 6 in.	.125	.100	.125	.150	.050
Analysis end of second period 1st 6 in.	.410	.450	.900	.275	.325
Analysis end of second period 2nd 6 in.	.210	.175	.200	.200	.200
Analysis end of second period 3rd 6 in.	.135	.125	.125	.175	.100
Analysis end of third period 1st 6 in.	.400	.400	.850	.275	.250
Analysis end of third period 2nd 6 in.	.200	.200	.225	.200	.175
Analysis end of third period 3rd 6 in.	.150	.150	.150	.175	.125
Analysis end of fourth period 1st 6 in.	.385	.375	.750	.250	.175
Analysis end of fourth period 2nd 6 in.	.220	.215	.280	.200	.150
Analysis end of fourth period 3rd 6 in.	.160	.150	.175	.200	.250
Analysis end of fifth period 1st 6 in.	.320	.300	.750	.240	.140
Analysis end of fifth period 2nd 6 in.	.230	.230	.280	.200	.120
Analysis end of fifth period 3rd 6 in.	.190	.160	.175	.200	.220
Analysis end of sixth period 1st 6 in.	.290	.260	.700	.200	.100
Analysis end of sixth period 2nd 6 in.	.240	.280	.300	.200	.140
Analysis end of sixth period 3rd 6 in.	.200	.200	.200	.240	.220
Decrease in per cent. of lime in 1st 6 in.	.145	.215	.225	.125	.425
Decrease in wt. of lime in 1st 6 in.	21.215	31.206	33.075	18.375	62.475
Increase in per cent. of lime in 2nd 6 in.	.028	.115	.115	.013	.090
Increase in wt. of lime in 2nd 6 in.	4.116	16.905	16.905	1.911	13.230
Increase in per cent. of lime in 3rd 6 in.	.075	.088	.075	.090	.175
Increase in wt. of lime in 3rd 6 in.	11.025	12.936	11.025	13.230	25.725

TABLE No. 11—Continued.

Pot No.		No. 14	No. 16	No. 18	No. 20	No. 23	No. 26
Kind of Soil		Sand	Sand	Sand	Sand	Sand	Sand
Lime		$MgCO_3$	$Ba(OH)_2$	Burnt Lime CaO	Burnt Lime CaO	Lime stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$
Analysis before starting Expt.	1st 6 in.	.588	.226	.475	.450	.350	.625
Analysis before starting Expt.	2nd 6 in.	.317	.000	.250	.200	.125	.300
Analysis before starting Expt.	3rd 6 in.	.154	.000	.100	.100	.050	.125
Analysis end of first period	1st 6 in	.578	.217	.450	------	------	------
Analysis end of first period	2nd 6 in.	.320	.005	.275	------	------	------
Analysis end of first period	3rd 6 in.	.154	.000	.100	------	------	------
Analysis end of second period	1st 6 in.	.541	.158	.400	.425	.310	.600
Analysis end of second period	2nd 6 in	.344	.042	.250	.200	.150	.312
Analysis end of second period	3rd 6 in.	.162	.026	.150	.112	.075	.150
Analysis end of third period	1st 6 in.	.526	.155	.350	.400	.250	.600
Analysis end of third period	2nd 6 in.	.362	.026	.275	.212	.175	.275
Analysis end of third period	3rd 6 in.	.153	.032	.200	.125	.100	.200
Analysis end of fourth period	1st 6 in.	.453	.136	.350	.350	.225	.500
Analysis end of fourth period	2nd 6 in.	.416	.050	.260	.237	.175	.340
Analysis end of fourth period	3rd 6 in.	.153	.040	.200	.150	.125	.200
Analysis end of fifth period	1st 6 in.	.362	.135	.320	.300	.200	.500
Analysis end of fifth period	2nd 6 in.	.456	.050	.260	.250	.170	.340
Analysis end of fifth period	3rd 6 in.	.189	.038	.220	.200	.150	.200
Analysis end of sixth period	1st 6 in.	.255	.118	.280	.230	.200	.400
Analysis end of sixth period	2nd 6 in.	.463	.063	.280	.275	.160	.400
Analysis end of sixth period	3rd 6 in.	.289	.039	.240	.225	.160	.240
Decrease in per cent. of lime in	1st 6 in.	.333	.108	.195	.220	.150	.225
Decrease in wt. of lime in	1st 6 in.	49.951	15.876	28.665	32.340	22.050	33.075
Increase in per cent. of lime in	2nd 6 in.	.146	.063	.03–	.075	.035	.100
Increase in wt. of lime in	2nd 6 in.	21.462	9.261	4.410	11.025	5.145	14.700
Increase in per cent. of lime in	3rd 6 in.	.135	.039	.140	.125	.110	.115
Increase in wt. of lime in	3rd 6 in.	19.845	5.733	20.580	18.375	16.170	16.905

TABLE No. 12.

Results Obtained on Clay Soil.

	Pot No.	No. 2	No. 5	No. 8	No. 11	No. 13
	Soil Used	Clay	Clay	Clay	Clay	Clay
	Lime Added	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$	Oyster Shells $CaCO_3$	Gypsum $CaSO_4$
Periods	Weight of Lime Added	33.39g	33.39g	33.39g	33.39g	33.39g
First	cc of water added	7380	7380	7380	7380	7380
First	cc of water collected	0000	0000	0000	0000	0000
First	wt. of lime in drainage water	.0000	.0000	.0000	.0000	.0000
Second	cc of water added	16760	16760	16760	16760	16760
Second	cc of water collected	9100	7600	9000	9700	9900
Second	wt. of lime in drainage water	.0660	.0900	.2000	.1450	.3350
Third	cc of water added	10000	10000	10000	10000	10000
Third	cc of water collected	5500	3200	4700	5600	7600
Third	wt. of lime in drainage water	.0718	.0812	.1218	.0530	.2462
Fourth	cc of water added	18700	18700	18700	18700	18700
Fourth	cc of water collected	4600	3100	3200	3400	3900
Fourth	wt. of lime in drainage water	.1037	.1000	.0437	.1092	.2937
Fifth	cc of water added	14750	14750	14750	14750	14750
Fifth	cc of water collected	2250	1500	230	2050	1800
Fifth	wt. of lime in drainage water	.1187	.0768	.0062	.0780	.1500
Sixth	cc of water added	16845	16845	16845	16845	16845
Sixth	cc of water collected	5900	4800	5700	6400	7300
Sixth	wt. of lime in drainage water	.2500	.2787	.0912	.5050	1.2125
	Total cc of water added for year	84425	84425	84425	84425	84425
	Total cc of water collected for year	27350	20250	22800	27150	28550
	Total wt. of lime recovered in drainage water	.6102	.6267	.4629	.8902	2.2374
	Per cent. of lime lost through drainage	1.82	1.87	1.38	2.66	6.69
	Wt. of lime removed per acre	73 lbs.	75 lbs.	55 lbs.	106 lbs.	268 lbs.

TABLE No. 12—Continued.

	Pot No.	No. 15	No. 17	No. 19	No. 21	No. 24	No. 27
	Soil Used	Clay	Clay	Clay	Clay	Clay	Clay
	Lime Added	MgCO$_3$	Ba(OH)$_2$	Lime CaO	Lime CaO	Lime Stone CaCO$_3$	Rock Phosphate Ca$_3$(PO$_4$)$_2$
Periods	Weight of Lime Added	33.39g	33.39g	33.39g	33.39g	33.39g	33.39g
First	cc of water added	7380	7380	7380	5609	5609	5609
First	cc of water collected	0000	0000	0000	0000	0000	0000
First	wt. of lime in drainage water	0000	0000	0000	0000	0000	0000
Second	cc of water added	16760	16760	16760	17750	17750	17750
Second	cc of water mollected	9500	8500	9900	3100	7100	9250
Second	wt. of lime in drainage water	.1102	.0000	.0900	.0800	.0860	.1260
Third	cc of water added	10000	10000	10000	15662	15662	15662
Third	cc of water collected	8730	5280	8830	5470	7500	7200
Third	wt. of lime in drainage water	.1908	.0000	.0937	.0787	.1530	.0937
Fourth	cc of water added	18700	18700	18700	17002	17002	17002
Fourth	cc of water collected	4350	4950	4750	4180	5300	4600
Fourth	wt. of lime in drainage water	.2115	.0099	.1000	.0687	.1062	.0787
Fifth	cc of water added	14750	14750	14750	8890	8890	8890
Fifth	cc of water collected	3900	2250	3800	100	680	100
Fifth	wt. of lime in drainage water	.2897	.0066	.1042	.0062	.0275	.0062
Sixth	cc of water added	16845	16845	16845	13199	13199	13199
Sixth	cc of water collected	7800	6600	7200	4200	6500	5200
Sixth	wt. of lime in drainage water	.7042	.0131	.3950	.3312	.6780	.1437
	Total cc of water added for year	84425	84425	84425	78114	78114	78114
	Total cc of water collected for year	34280	27580	34480	17050	27080	26350
	Total wt. of lime recovered in drainage water	1.5064	.0296	.7829	.5648	1.0507	.4483
	Per cent. of lime lost through drainage	4.59	.08	2.04	1.69	3.14	1.34
	Wt. of lime removed per acre	180 lbs	35 lbs	93 lbs	67 lbs	126 lbs	53 lbs

TABLE No. 13.

Analysis of Different Depths of Soil at End of Each Period.

	Pot No.	No. 2	No. 5	No. 8	No. 11	No. 13
	Soil	Clay	Clay	Clay	Clay	Clay
	Lime	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$	Oyster Shells $CaCO_3$	Gypsum $CaSO_4$
Analysis before starting expt.	1st 6 in.	.362	.387	.600	.375	.400
Analysis before starting expt.	2nd 6 in.	.162	.250	.125	.125	.187
Analysis before starting expt.	3rd 6 in.	.087	.200	.100	.125	.100
Analysis end of first period	1st 6 in.	.350	.387	.600	.362	.400
Analysis end of first period	2nd 6 in.	.175	.250	.125	.150	.200
Analysis end of first period	3rd 6 in.	.100	.200	.087	.125	.100
Analysis end of second period	1st 6 in.	.362	.362	.600	.350	.375
Analysis end of second period	2nd 6 in.	.150	.262	.125	.125	.200
Analysis end of second period	3rd 6 in.	.087	.175	.125	.150	.137
Analysis end of third period	1st 6 in	.350	.375	.575	.325	.325
Analysis end of third period	2nd 6 in.	.162	.250	.135	.200	.212
Analysis end of third period	3rd 6 in.	.087	.175	.100	.137	.137
Analysis end of fourth period	1st 6 in.	.350	.375	.550	.325	.325
Analysis end of fourth period	2nd 6 in.	.125	.262	.150	.200	.212
Analysis end of fourth period	3rd 6 in.	.100	.200	.112	.140	.125
Analysis end of fifth period	1st 6 in.	.320	.360	.560	.320	.320
Analysis end of fifth period	2nd 6 in.	.200	.280	.140	.200	.220
Analysis end of fifth period	3rd 6 in.	.100	.200	.125	.120	.140
Analysis end of sixth period	1st 6 in.	.300	.330	.540	.280	.300
Analysis end of sixth period	2nd 6 in.	.180	.300	.140	.200	.220
Analysis end of sixth period	3rd 6 in.	.100	.200	.140	.140	.140
Decrease in per cent. of lime in	1st 6 in.	.062	.057	.060	.095	.100
Decrease in wt. of lime in	1st 6 in.	9.114	8.379	8.820	13.965	14.700
Increase in per cent. of lime in	2nd 6 in.	.018	.050	.015	.075	.033
Increase in wt. of lime in	2nd 6 in.	2.646	7.350	2.205	11.025	4.851
Increase in per cent. of lime in	3rd 6 in.	.013	.000	.040	.015	.040
Increase in wt. of lime in	3rd 6 in.	1.911	.000	5.880	2.205	5.880

TABLE No. 13—Continued.

	Pot No.	No. 15	No. 17	No. 19	No. 21	No. 24	No. 27
	Soil	Clay	Clay	Clay	Clay	Clay	Clay
	Lime	$MgCO_3$	$Ba(OH)_2$	Burnt Lime CaO	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$
Analysis before starting expt..	1st 6 in.	.688	.228	.362	.337	.487	1.350
Analysis before starting expt..	2nd 6 in.	.362	.000	.175	.200	.132	.150
Analysis before starting expt..	3rd 6 in.	.344	.000	.100	.125	.112	.100
Analysis end of first period....	1st 6 in.	.688	.224	.350	------	------	------
Analysis end of first period....	2nd 6 in.	.360	.000	.200	------	------	------
Analysis end of first period....	3rd 6 in.	.340	.000	.100	------	------	------
Analysis end of second period..	1st 6 in.	.688	.215	.325	.325	.475	1.325
Analysis end of second period..	2nd 6 in.	.360	.005	.200	.225	.125	.175
Analysis end of second period..	3rd 6 in.	.344	.000	.100	.137	.120	.125
Analysis end of third period...	1st 6 in.	.670	.210	.325	.300	.450	1.225
Analysis end of third period...	2nd 6 in.	.344	.005	.200	.237	.137	.175
Analysis end of third period...	3rd 6 in.	.362	.005	.100	.137	.120	.125
Analysis end of fourth period..	1st 6 in.	.598	.200	.325	.287	.445	1.220
Analysis end of fourth period..	2nd 6 in.	.407	.015	.200	.150	.137	.190
Analysis end of fourth period..	3rd 6 in.	.375	.005	.100	.187	.125	.135
Analysis end of fifth period...	1st 6 in.	.579	.190	.325	.287	.430	1.200
Analysis end of fifth period...	2nd 6 in.	.400	.025	.180	.160	.145	.200
Analysis end of fifth period...	3rd 6 in.	.398	.010	.120	.160	.130	.140
Analysis end of sixth period...	1st 6 in.	.570	.187	.300	.287	.420	1.200
Analysis end of sixth period...	2nd 6 in.	.400	.025	.180	.180	.145	.200
Analysis end of sixth period...	3rd 6 in.	.406	.012	.140	.160	.140	.140
Decrease in per cent. of lime in.	1st 6 in.	.118	.041	.062	.050	.067	.150
Increase in wt. of lime in......	1st 6 in.	17.346	6.027	9.114	7.350	9.849	22.050
Increase in per cent. of lime in.	2nd 6 in.	.038	.025	.005	.000	.013	.050
Increase in wt. of lime in......	2nd 6 in.	5.586	3.675	.735	.000	1.911	7.350
Increase in per cent. of lime in.	3rd 6 in.	.062	.012	.040	.045	.028	.040
Increase in wt. of lime in......	3rd 6 in.	9.114	1.764	6.880	7.615	4.116	6.880

TABLE No. 14.

Results Obtained on Loam Soil.

	Pot No.	No. 3	No. 6	No. 9	No. 22	No. 25	No. 28
	Soil Used	Loam	Loam	Loam	Loam	Loam	Loam
	Lime Added	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$
Periods	Weight of Lime Added	33.39g	33.39g	33.39g	33.39g	33.39g	33.39g
First	cc of water added	7380	7380	7380	5609	5609	5609
First	cc of water collected	0000	0000	0000	1100	750	1100
First	wt. of lime in drainage water	.0000	.0000	.0000	.0470	.0180	.0230
Second	cc of water added	16760	16760	16760	17750	17750	17750
Second	cc of water collected	8300	8000	8100	5300	6650	8650
Second	wt. of lime in drainage water	.2100	.2740	.5200	.1200	.2100	.2050
Third	cc of water added	10000	10000	10000	15662	15662	15662
Third	cc of water collected	7200	5600	7050	4700	7300	7300
Third	wt. of lime in drainage water	.2312	.2875	.2750	.5175	.7452	.2687
Fourth	cc of water added	18700	18700	18700	17002	17002	17002
Fourth	cc of water collected	3800	3750	2370	4200	4000	3300
Fourth	wt. of lime in drainage water	.2500	.1812	.1065	.2450	.3187	.1337
Fifth	cc of water added	14750	14750	14750	8890	8890	8890
Fifth	cc of water collected	700	1950	0000	720	225	100
Fifth	wt. of lime in drainage water	.0500	.2875	.0000	.0565	.0450	.0625
Sixth	cc of water added	16845	16845	16845	13199	13199	13199
Sixth	cc of water collected	6200	5600	7400	5000	3300	5800
Sixth	wt. of lime in drainage water	1.3062	1.9125	.3187	1.1075	1.6963	.6037
Total cc of water added for year		84425	84425	84425	78114	78114	78114
Total cc of water collected for year		26200	24900	24920	21020	22225	26250
Total wt. of lime recovered in drainage water		2.0474	2.9427	1.1202	2.0935	2.8331	1.2966
Per cent. of lime lost through drainage		6.13	8.51	3.35	6.20	8.18	3.88
Wt. of lime removed per acre		245 lbs	353 lbs	134 lbs	251 lbs	339 lbs	155 lbs

TABLE No. 15.

Analysis of Different Depths of Soil at End of Each Period.

	Pot No.	No. 3	No. 6	No. 9	No. 22	No. 25	No. 28
	Soil	Loam	Loam	Loam	Loam	Loam	Loam
	Lime	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$	Burnt Lime CaO	Lime Stone $CaCO_3$	Rock Phosphate $Ca_3(PO_4)_2$
Analysis before starting expt.	1st 6 in.	.375	.375	.825	.350	.575	.600
Analysis before starting expt.	2nd 6 in.	.117	.125	.475	.125	.275	.225
Analysis before starting expt.	3rd 6 in.	.100	.100	.175	.075	.150	.200
Analysis end of first period	1st 6 in.	.350	.365	.820	------	------	------
Analysis end of first period	2nd 6 in.	.125	.125	.475	------	------	------
Analysis end of first period	3rd 6 in.	.100	.100	.180	------	------	------
Analysis end of second period	1st 6 in.	.337	.357	.800	.350	.500	.575
Analysis end of second period	2nd 6 in.	.150	.150	.500	.125	.300	.250
Analysis end of second period	3rd 6 in.	.100	.100	.180	.075	.175	.200
Analysis end of third period	1st 6 in.	.275	.325	.775	.300	.475	.560
Analysis end of third period	2nd 6 in.	.162	.175	.500	.150	.300	.250
Analysis end of third period	3rd 6 in.	.125	.112	.200	.100	.200	.200
Analysis end of fourth period	1st 6 in.	.250	.300	.760	.250	.450	.540
Analysis end of fourth period	2nd 6 in.	.175	.175	.500	.150	.325	.250
Analysis end of fourth period	3rd 6 in.	.125	.125	.200	.125	.200	.210
Analysis end of fifth period	1st 6 in.	.240	.290	.750	.240	.440	.500
Analysis end of fifth period	2nd 6 in.	.180	.175	.510	.150	.300	.275
Analysis end of fifth period	3rd 6 in.	.125	.125	.200	.125	.220	.225
Analysis end of sixth period	1st 6 in.	.200	.270	.700	.200	.420	.490
Analysis end of sixth period	2nd 6 in.	.200	.170	.570	.160	.310	.265
Analysis end of sixth period	3rd 6 in.	.140	.140	.240	.140	.220	.240
Decrease in per cent. of lime in	1st 6 in.	.175	.105	.125	.150	.155	.110
Decrease in weight of lime in	1st 6 in.	25.725	15.435	18.375	22.050	22.785	16.170
Increase in per cent. of lime in	2nd 6 in.	.083	.045	.035	.035	.035	.040
Increase in weight of lime in	2nd 6 in.	12.201	6.615	5.145	5.145	5.145	5.880
Increase in per cent. of lime in	3rd 6 in.	.040	.040	.065	.065	.070	.040
Increase in weight of lime in	3rd 6 in.	5.880	5.880	9.555	9.555	10.290	5.880

Discussion of Results with Sand Soil.

In discussing the results obtained on the sand soil in tables No. 10 and No. 11, we will take up the salts that are least depleted, first, and follow from the lowest to the highest in regular order.

BARIUM HYDRATE.

Barium hydrate, pot No. 16, as shown by table No. 10, is the salt that is least depleted of the eight alkalies used. Though very soluble in water, as shown further on, this salt is less active in its movements through the soil than any of the salts worked with.

In table No. 10 it will be seen that no barium was found in the drainage water for the first two periods, though 24140cc. of water had been added to the pot and 10000cc. of drainage water had been collected. In period three, after 34140cc. of water had been added and 17530cc. collected, there was found .1340 grams of barium oxide in 7530cc. of drainage water, the amount collected at the end of the third period. From the end of this period through the fourth, fifth and sixth periods a small amount of the oxide was found in the drainage water at the end of each period, the sum total being .7230 grams of barium oxide, making the percentage depletion equal to 2.16% for the year.

In regard to the movement of this salt through the soil, it will be seen from table No. 11 that the rate of movement is slow and in accordance with the amount found in the drainage water, no barium oxide being found in the third six inches of the pot until the third period after the pot had been under experiment for five months and received 34140cc. of water. From the third period on through the other three periods the movement is very slow, the percentage increase in the third six inches at the end of the sixth period being .039 per cent. The results as summarized in table No. 11 show a decrease of 15.876 grams of barium in the first six inches, and an increase of 9.261 grams and 5.733 grams in the second and third, respectively.

As would be expected from the solubility of barium hydrate in water one would judge that this salt would have a much higher rate of diffusion and depletion than was found by actual experiment. Barium hydrate being a very strong and active alkali, it can be concluded that this salt is readily active in forming insoluble compounds and replacing some salt or salts in the insoluble and double silicates of the soil. Working with barium at this Station (Bulletin 110) it was found that this salt did not have the lasting effect that lime and magnesium had, but that it produced a decided increase in yield in the early years and not so much in the later years. This would seem to support the theory that this salt, after replacing other salts in the silicate, remained there in a combined state, thus checking its movement from particle to particle through the soil.

CALCIUM PHOSPHATE.

Phosphate of lime in the form of finely ground raw phosphate rock is the next following barium hydrate. Two pots were treated with this salt, pots 7 and 26; pot 7 being placed under artificial conditions and pot 26 subject to natural conditions. Though much more insoluble than the barium salt, this salt moves with a greater degree of rapidity than barium hydrate. In table No. 10 it will be seen that in both pots the oxide of calcium was found in the drainage water at the end of each period. In comparing the total weight of lime that percolated through the soil under different conditions, it is found that more lime was present in the drainage water of the pot under natural conditions, though less water was collected for the year. This, so far as can be seen, is due to the extreme temperature to which the outside pot was subjected.

In considering the movement of the phosphate of lime through the soil, it is found that there is the same percentage decrease in the first six inches in both pots; in the second and third there is a slight difference in favor of the pot under natural conditions, more lime being diffused through the soil to the lower six inches.

CALCIUM OXIDE.

Three pots were treated with calcium oxide, No. 1, No. 18 and No. 20; No. 1 and No. 20 treated with commercial oxide of calcium and No. 18 with C. P. calcium oxide. No. 1 and No. 18 subject to artificial conditions and No. 20 under natural conditions.

This salt is but little more diffusible than calcium phosphate, though it is a much more active salt than the latter, and the most soluble form of calcium used in the study. Therefore, from its solubility, it would be expected that its movements through the soil would be much faster than the more insoluble forms, as the phosphate and carbonate.

Like barium hydrate, calcium oxide is a very strong and active alkali, and for this reason its slow movement through the soil is explained to a large extent. Its action on soil acidity would probably tend to use up its activeness and render a more insoluble form. Then in the process of neutralization it is believed that the greater part of the oxide is used in replacing other salts which were held by the soil in an insoluble form.

In consideration of the results obtained on the two oxides used the tables show but little difference in respect to the commercial and chemically pure salts, each showing very nearly the same percentage of depletion. In respect to the rate of diffusion the chemically pure salt moves to a slight degree more rapidly than the commercial salt, yet the difference is not marked enough to note as a great variation.

The pots subject to different conditions showed about the same relative results as was noted with the phosphate of lime; wherein the pot under natural conditions did not give up as much lime to the drainage water as did the pot under artificial conditions. But little difference is noted between the rate of diffusion of the salts under both conditions, the small difference being in favor of the pot subjected to outside conditions.

It is interesting to note the gradual increase of calcium oxide found in a solution from the sand soil. There was a gradual increase from period to period. Almost half of the lime that was depleted was collected during the last period.

CALCIUM CARBONATE.

Calcium carbonate, the most insoluble salt of calcium in water, is found to rank fourth as compared with the eight alkalies used. Though this salt does not seem to diffuse through the soil at a much higher rate than the calcium phosphate and calcium oxide, yet there is a difference in the amount of lime found in the drainage water which places it before the other two salts.

Two forms of calcium carbonate were used, finely ground limestone and powdered oyster shells. Pots No. 4 and No. 23 received limestone and No. 10 oyster shells, giving two pots under artificial conditions, No. 4 and No. 10, and one under natural conditions, No. 23.

In comparing the results obtained, it is readily seen that the difference is very slight. The limestone and oyster shells, both giving 2.6 grams of calcium oxide in the drainage, as a total for the year. In respect to the rate of diffusion, there is a difference in the rate of movement of each through the soil, the ground limestone having a more active movement than the ground oyster shells.

Of the two pots under different conditions the same is noted as in respect to the phosphate and oxide; the salt in the outside pot diffuses through the soil more rapidly than the one under artificial conditions.

MAGNESIUM CARBONATE.

Though a very insoluble form of magnesium in water, it is found that in a soil solution this salt diffuses much faster than any of the salts discussed up to this time.

One pot was treated with magnesium carbonate, pot No. 14, and placed under artificial conditions. On examining the results in table No. 10 it is readily seen that magnesium oxide is found in the drainage water to a much larger extent than any other salts with exception of calcium sulphate. The most striking point in respect to the study of this salt is the gradual increase in weight of the oxide in the drainage water as collected at the end of each period. Starting off relatively low, the rate of depletion gradually increases from .0490 grams to 1.7530 grams of magnesium oxide from period to period until at the end the sum total gives 5.2116 grams depleted in one year giving a percentage of 15.60 or 625.3 lbs. of magnesium oxide removed from the first eighteen inches of an acre of soil in one year.

The movement of the magnesium carbonate as shown in table No. 11 is very regular and by far more rapid than the other substances used. As can be seen from the table, not only did the magnesium added to the pot move through to the two lower depths of the soil, but there is a movement of over 15 grams of magnesium oxide held by the soil before the carbonate was added. In all there was 48.9 grams of magnesium oxide removed from the first six inches of the pot and an increase of 21 and 19 grams in the second and third six inches.

CALCIUM SULPHATE.

From the results obtained with calcium sulphate in a sand soil it is readily seen that this salt is in a class by itself in respect to the other salts of calcium studied.

In table No. 10, showing the amount of calcium oxide in the drainage water, more oxide of calcium was found at the end of one period than was found in the drainage water for any pot for the year. 18.1476 grams of CaO were found in the drainage water at the end of the experiment, which is equal to 54.38 per cent. of the total amount added or 2177.4 lbs. of CaO depleted out of the first eighteen inches of one acre of sand soil in one year.

In respect to the movement of calcium sulphate through the soil, there is a tendency for the salt to move through the different depths in a solid column, there being nothing in the soil to attract calcium in the form of the sulphate, nor do the results show that calcium in this form would play any great part in soil fertility when the movement is as fast as found in the experiment conducted.

CLAY SOILS.

Tables Nos. 12 and 13 show the results obtained with the eight alkalies on the clay soil, the same number of pots being used and placed under exactly the same conditions.

.The action of these salts on a clay soil corresponds in their behavior with the action when they were applied on the sandy soil; barium hydrate being least depleted, calcium phosphate second, calcium oxide third, calcium carbonate fourth, magnesium carbonate fifth and calcium sulphate sixth.

The results as obtained are in the most part so small that definite conclusions would be hard to draw were it not for the very positive results obtained on the sand soil. As is seen by examining the results in table No. 12, only three pots gave more than one gram of oxide in the drainage water during the whole experiment, calcium sulphate having the greatest depletion of 2.2374 grams, magnesium carbonate 1.5064 grams and ground limestone 1.151 grams, whereas the other salts are all less than one gram, barium hydrate in pot No. 17 giving only .0296 grams for the year.

In regard to the rate of diffusion of the salts through the different depths of the soil the movement is exceedingly slow in comparison with the sand soil, and speaking as a whole, it can be said that clay soils are practically set with respect to the movement of salts within the soil.

In considering the great difference found between the sand and clay soil, it must be borne in mind that the movement of any salt in a soil is to a large extent governed by the physical constitution of the soil, and the extent and direction of these movements the effect produced by these salts will depend. Clay soils contain from 50 to 75 per cent. of silt and clay, the finest particles known by soil workers, which enormously increases the surface of the soil particles. Thus the cohesion between the particles of the soil is increased by an increase in their surface. It can readily be understood that any movement of water in a soil, whether of the nature of a downward percolation or a rise, brought about by capillary action, must carry with it the salts which the water holds in solution. As these salts are dissolved and pass on through a soil, the soil having the least resistance or having less cohesion between its particles as a sand soil would naturally be the one to allow the greatest diffusion, whereas, with a clay soil with its many fine particles, acts, so to speak, as a filter, freeing the descending solution of its salts, the salts in turn probably replacing some salts in the particles which are again taken up by the descending solution and carried on through the soil, giving a continuous replacement of the salts held in combination. Thus we will find a difference in the rate of diffusion of different salts in soils of different textures and different types of soils.

Loam Soils.

With respect to the study on a loam soil, only three salts were used, six pots being treated, three placed under artificial conditions and three subject to natural conditions, as follows: pots Nos. 3. 6 and 9 treated with calcium oxide, calcium carbonate, and calcium phosphate respectively, and placed under artificial conditions, and pots Nos. 22, 25 and 28 treated as above and placed under natural conditions, each pot being treated with the same weight of the alkali as the sand and clay soils and each receiving the same amount of water.

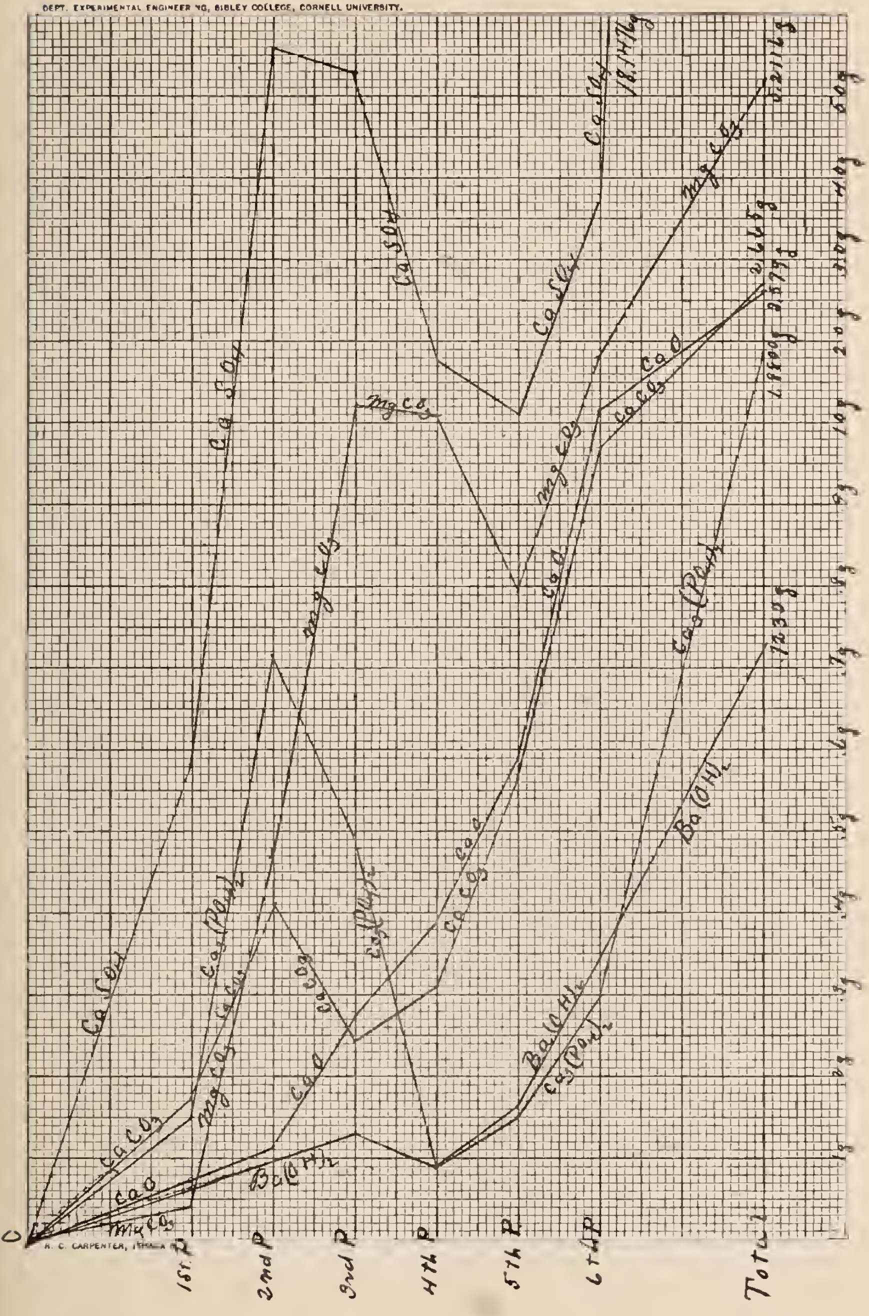
The results obtained on the loam soil show it to fall between the sand and clay soils with reference to the rate of diffusion and depletion, the movement of the salts being slower than with the sand soil, but much faster than the clay soil.

As was found in the sand and clay soils, the behavior of the limes used on the loam soil is in accordance with the results on the other two, so far as the investigation was carried, calcium phosphate being the least diffusible, calcium oxide next and calcium carbonate the greatest of the three.

Loss of Lime by Depletion.

In consideration of the great variation found in exhausting the soil of lime in different forms by depletion, it is best illustrated in the following diagram showing the weights of the different limes removed from the sand soil by the drainage water from period to period by means of a curve.

In the main it is found that each salt, with exception to barium hydrate, which gives but a very slight curve, starts off at very nearly the same point, giving less than .6 of a gram of the oxide up to the drainage water at the end of the first period.


DEPT. EXPERIMENTAL ENGINEERING, SIBLEY COLLEGE, CORNELL UNIVERSITY.
R. C. CARPENTER, ITHACA N.Y.
C
1st P
2nd P
3rd P
4th P
5th P
6th P
Total
CaSO4
CaCO3
CaO
MgCO3
Ba(OH)2
Ca3(PO4)2
18.1417g
5.2116g
2.665g
2.579g
1.9600g
1.230g
50g
40g
30g
20g
10g
9g
8g
7g
6g
5g
4g
3g
2g
1g

In following the lines from period to period it is readily seen that calcium phosphate, oxide, and carbonate run very nearly parallel with each other, the oxide and carbonate being more closely related than the phosphate, the oxide and carbonate increasing in a gradual curve through to the end of the last period.

Magnesium carbonate forms a curve more or less broken in its scope, but is considerably greater than either the phosphate or oxide or carbonate of calcium, starting at .0490 grams and ending at the total at 5.2116 grams.

The salt having the greatest variation in its curve is that of calcium sulphate. Starting at .5815 it goes in a very broken line from period to period increasing and decreasing according to the amount of water collected until the curve reaches a total of 18.1476 grams.

From the above illustration it is shown that different salts of calcium and magnesium are removed from the soil by drainage at very different rates of speed, and though this rate varies considerably, yet the loss of lime even with the salt that is least depleted is large when calculated to one acre.

Calculating the loss of lime that is suffered by drainage when a sand soil is treated with calcium phosphate, it is found from the results in table No. 10 that over 225 pounds of pure calcium oxide is leached through the soil below the first eighteen inches in one year, which means that a total weight of 4,000 pounds of pure calcium oxide in the form of phosphate would be practically lost from the fertile part of a sand soil in 17 years. Calcium oxide and calcium carbonate would be lost in 13 years, magnesium carbonate in six and one-half years, whereas calcium sulphate would last only two years.

This loss by drainage, however, would not be so great in respect to a loam soil, and the loss would be only slight if clay soils were limed. The finer the particles of the soil the less is the loss.

The great loss of calcium oxide by the drainage water when calcium sulphate is added to the soil would tend to support the idea that the per cent. of sulphuric acid in the soil plays a most important part on the rate of diffusion and depletion of different limes in the soil. As is seen from the tables, calcium in the form of sulphate is not retained by the soil longer than sufficient rain is received to carry it off into the drainage water. The common action of sulphuric acid on calcium would be to form the sulphate which as found is very soluble in a soil solution, and is easily moved as the soil water moves through the different depths of the soil and out into the drainage water.

LIME REMOVED FROM THE SOIL BY THE CROP.

The water present in a fertile soil always contains salts in solution; the quality of salts dissolved in water is usually very small, but their importance for plant nutrition is very great. A part of these salts is annually taken up as plant food by the roots of the crops growing on the land, a part is also annually removed by percolating water as is shown in the preceding pages.

As this study is in respect to the amount of lime removed from the soil, a table has been compiled showing the weight of lime (CaO) removed by crops. The analysis of the different plants, were taken from the work of E. Wolff Hohenheim, on the ash and nitrogen constituents of agricultural products, published in Stockbridge's book on Rocks and Soils. The weights of the respective crops were taken from the Census report, the U. S. Agricultural report and the data collected by the agricultural departmment of this institution. The table in the most part shows the weight and per cent. of lime of the heavier and most important crops grown in this country.

On referring to the table it is readily seen that the hay crop is one that takes up and removes from the soil the largest quantity of lime, but even a cutting of three tons, carries off no more than 100 pounds per acre. Assuming the weight of the soil upon an acre, taken to the depth of one foot, to be 4,000,000 pounds and the per cent. of lime to be at least .10%, then there would be 4,000 pounds of lime to one acre. The lime ingredients of a heavy hay crop amounts, therefore, to one-fortieth of the lime held by the soil, admitting the crop to be fed exclusively by the twelve inches next the surface. Accordingly no less than forty full crops of hay would require to be taken off to consume all the lime of the soil to this depth, which would mean a period of at least forty years.

Thus, as from the above illustration, it can be shown that all the crops given in the table would remove but a small portion of the total lime held by the soil, and as could be looked on, would give almost an inexhaustable supply of lime if such existed in the soil in a soluble form and no loss was maintained by diffusion and depletion. But, as is well known, the high percentage of soil constituents, as obtained by strong acid digestion, does not mean that all salts found in the soil are in a form available for plant food.

A soil, to be productive, must render annually, as the crop needs it, a sufficient amount of material in a form available to the plants. As a matter of fact soil is a difficult soluble substance, composed mostly of silicates and aluminates, or difficult soluble compounds of silica, alumina, potash, soda and lime in various forms. These compounds through different agencies are gradually rendered more or less soluble and more or less readily available to plants thus producing what is termed a fertile soil. If the food material is not brought into a condition in which it is available to the plants, the land is as poor as though it actually contained no plant food.

It is perfectly safe to say that the conditions of the so-called worn-out soils is due, not to an actual extraction or lack of plant food, but to the chemical conditions in which it now is, in which it is unavailable to plants, and that the restoration of the fertility of that land must be, not necessarily in the addition of plant food to the soil, but in bringing about such changes in the physical and chemical condition which will make the plant food available to crops.

	Weight of crop per acre.	Weight of lime in 1000 parts.	Weight of lime removed per acre.
Meadow hay	3000	9.5	28.5
Rye grass	3000	4.3	12.9
Timothy	3000	4.7	14.1
Orchard grass	3000	3.1	9.3
Red clover (ripe)	4000	15.8	63.2
White clover (in flower)	4000	18.4	73.6
Lucerne	5000	25.2	126.0
Green vetch (in flower)	4000	16.3	65.2
Cowpea hay	4000	12.7	50.8
Wheat straw	4000	2.7	18.3
Wheat grain	1500	.5	
Rye straw	2500	3.1	8.0
Rye grain	810	.5	
Barley straw	2500	3.3	8.37
Barley grain	1200	.1	
Oat straw	2500	4.3	11.74
Oat grain	990	1.0	
Corn straw	4000	4.9	20.08
Corn grain	1680	.3	
Buckwheat straw	2000	9.5	19.28
Buckwheat grain	566	.5	
Pea straw	3000	15.9	48.36
Pea grain	600	1.1	
Soja bean straw	3500	14.6	52.03
Soja bean grain	550	1.7	

	Weight of crop per acre.	Weight of lime in 1000 parts.	Weight of lime removed per acre.
Field bean straw	3500	11.1	39.67
Field bean grain	550	1.5	
Rape straw	2500	11.7	34.75
Rape grain	1000	5.5	
Potatoes (white)	6000	.3	1.8
Artichokes	15000	.3	4.5
Beets	25000	.3	7.5
Sugar beets	15480	.7	10.78
Ruta Bagas	15000	.9	13.5
Carrots	8000	.9	7.2
Parsnips	36000	1.1	36.6
Asparagus shoots	3000	.6	1.8
Horse radish	8000	2.0	16.0
Sweet potatoes	5000	.7	3.5
Garden radish	5000	.7	3.5
Celery tubers	6000	2.3	13.8
Cucumber fruit	37000	.4	14.8
Squash fruit	20000	.3	12.0
Cabbage	8649	1.2	10.47
Cauliflower	8000	.5	4.00
Lettuce	10000	.5	5.00
Onions	4950	.9	4.49
Tobacco	800	76.6	61.28
Gooseberries	5000	.4	2.00
Strawberries	5000	.5	2.5
Grapes	5500	1.0	5.5
Spinach	10000	1.9	19.0
Rhubarb	9000	8.4	75.6

By comparing the weight of lime removed by the crop, with the weight removed by depletion, it is found that even the heaviest crop does not remove in a year more than one-third as much lime from the soil as is removed by the drainage water with the least diffusible salt of calcium.

THE EFFECT OF CARBON DIOXIDE ON THE SOLUBILITY OF THE ALKALIES USED IN THE EXPERIMENT AND THE ACTION OF SAME ON THE MOVEMENT OF CALCIUM OXIDE THROUGH THE SOIL.

In determining the effect of carbon dioxide on the solubility of the alkalies, the solubility of each salt in water at 25 degrees C. (°F) was determined and the results obtained compared with the solubility of the salts in water charged with carbon dioxide (CO_2) at 25 degrees C.

For the estimation of the solubility of the salts in water, a known weight, from 2 to 5 grams, of the sample was shaken every half hour for 12 hours in 1000cc of water, at 25 degrees C., allowed to stand over night, and the oxide determined in an aliquot portion of the filtered solution.

For the determiation of the solubility of the salts in water charged with carbon dioxide, the method described above was used; the solution being made at a temperature of 25 degrees C. A charge of .145 grams of CO_2 to 100cc of water was obtained giving .725 grams of CO_2 to 500cc of water which is equal to 1.0218 grams of carbonic acid in 500cc of water.

In Table No. 16 showing the solubility of the salts in water and carbon dioxide, the percentage of solubility was estimated on the basis of the total per cent. of the oxide held in combination by the different salts.

TABLE No. 16.

Showing Solubility of Alkalies.

	Burnt Lime Com CaO	Powdered Lime Stone $CaCO_3$	Powdered Oyster Shells $CaCO_3$	Phosphate Rock $Ca_3(PO_4)_2$	Gypsum $CaSO_4$	Pure Lime CaO	Magnesia Lime $MgCO_3$	Barium Hydrate $Ba(OH)_2$
Weight of sample used....	2 g	5 g	5 g	5 g	2 g	2 g	5 g	2 g
Weight soluble in 1000cc H_2O at 25 degrees C.....	90.96	.015	.0275	.0100	.4491	.9260	.0670	.8062
Per cent soluble...........	64.12	.56	1 16	1.45	58.51	48.26	3 77	80.17

Weight of Sample soluble in water (H_2O) charged with CO_2 at 25 degrees C.

Weight of sample used...	1 g	1 g	1 g	1 g	1 g	1 g	1 g	1 g
Weight sol'ble in 500cc of sol	1750	.1887	.0962	.0212	.2663	.0187	.1902	4049
Per cent soluble.....	24.65	25.31	20.25	15.43	69.40	1.94	53.53	82 65
Decrease solubility per cent	39.47	0000	0000	0000	0000	56 65	0000	0000
Increase solubility per cent	0000	24 75	19.09	13.98	10.90	0000	49.76	2.39

In consideration of the solubility of the eight salts in water charged with carbon dioxide (CO_2), the most striking effect is found with the calcium oxides, wherein there is a decrease in the case of the C. P.

CaO of 56.65 per cent. and 39.47 per cent. in the case of the commercial oxide of calcium.

With respect to the phosphate, sulphate, the two carbonates of calcium and magnesium carbonate, there is a very marked increase in the percentage solubility of these salts in a carbon dioxide solution. Calcium sulphate, though very soluble in water, is much more soluble in a solution charged with CO_2. Calcium carbonate, phosphate and magnesium carbonate as shown in the table are but slightly soluble in water whereas their solubility in carbonic acid is increased 24.75 per cent., 19.09 per cent. for the carbonates, 13.98 per cent. for the phosphate and 49.76 per cent. for magnesium carbonate.

The barium salt as shown by the figures in the table is but slightly affected by CO_2, the increase being only 2.39 per cent.

Thus, of the eight alkalies we find two that are decreased in solubility, five that are greatly increased in solubility, whereas, only one is slightly increased in solubility in water charged with carbon dioxide.

In determining the effect of carbon dioxide (CO_2) on calcium oxide in the soil, three pots such as used in the other experiments were filled in the same way with sand, clay and loam soils. Before adding the calcium oxide 10,000cc of water were added to each pot at intervals throughout seven days, so as to have the soil in a saturated condition, thereby giving approximately an equal amount of drainage water from each pot from period to period. After being assured that all the water had percolated through after saturation, the top six inches of each pot was well mixed with 46,90 grams of commercial oxide of calcium amounting to 33.39 grams of pure calcium oxide. After thus having the soil in a saturated condition and the lime added well mixed with the top six inches, the pots were placed in a cellar where a constant temperature of 25 degrees C. was maintained.

When the temperature of the top six inches of the soil became a constant of 25 degrees C. 10,000cc of distilled water were added during the course of seven days, and allowed to percolate through the soil, being caught at the outlet as shown in Fig. 1, in a two liter bottle. After percolation ceased, the drainage water was measured and calcium oxide estimated as described under analysis of drainage water.

During the course of the next twenty-eight days solutions 1/10, ¼, ½ and 4/4 charged with CO_2 amounting to 10,000cc each were added in periods of seven days each; the drainage water at the end of each period being measured and the amount of calcium oxide estimated.

Each of the above solutions was charged at 25 degrees C., making 1.450 grams of CO_2 in 10,000cc 1/10 charged; 3.625 grams ¼ charged; 7.250 grams ½ charged; and 14.50 grams 4/4 charged. Thus for the four periods each pot received 40,000cc of water which contained as a total 26.825 grams of CO_2, equivalent to 38.4145 grams of carbonic acid.

In Table No. 17 is shown the results obtained on calcium oxide in the three soils when treated with solutions of different strengths of carbonic acid.

In the main the results show a decided decrease in the total weight of calicum oxide found in the drainage water as the stronger solutions are added. The most decided effect is found in respect to the first and second periods, where distilled water was added in the first and water 1/10 charged with CO_2 in the second. As is seen by the table there is over one gram difference between the total weight in the sand and loam soils, where, as with the clay soil, the decrease is .225 grams.

From the second period on through the fifth as the solutions grow stronger, there is a slight decrease in respect to the sand and loam, but a more decided decline with the clay soil, decreasing through to the last period.

TABLE No. 17.

	Pots	No. 1	No. 2	No. 3
	Soils	Sand	Clay	Loam
	Lime	CaO	CaO	CaO
	Weight of Lime Added	33.39g	33.39g	33.39g
First period	cc of distilled water added	10000	10000	10000
	cc of drainage water collected	7000	5850	7650
	weight of lime in drainage water	1.5875	.9500	1.2875
Second period	cc of water 1-10 charged with CO_2 added	10000	10000	10000
	cc of drainage water collected	10000	10000	9500
	wt. of lime in drainage water	.4375	.7250	.4375
Third period	cc of water 1-4 charged with CO_2 added	10000	10000	10000
	cc of drainage water collected	9500	9350	9000
	wt. of lime in drainage water	.4250	.3875	.4250
Fourth period	cc of water 1-2 charged with CO_2 added	10000	10000	10000
	cc of drainage water collected	9000	9500	8700
	wt. of lime in drainage water	.4125	.2750	.4250
Fifth period	cc of water 4-4 charged with CO_2 added	10000	10000	10000
	cc of drainage water collected	9000	9000	9000
	wt. of lime in drainage water	.3750	.2000	.3500

In considering the total decrease from the first to the fifth periods it is found that the percentage decrease is very closely related for all three soils, taking for instance the difference in the weights between the first and fifth periods and dividing this difference by the weight obtained at the end of the first period and calculate to per cent., it is found that the sand runs 77.07 per cent., the clay 78.94 per cent. and the loam 72.73 per cent., or an average of 76.24 per cent. decrease caused by the addition of 38.4145 grams of carbonic acid.

In summing up the results obtained on the effect of carbon dioxide on the alkalies, the movement of calcium oxide through the three soils, and the relation it bears to the rate of diffusion and depletion of lime in the soil, it is readily seen that its influence is in no way insignificant.

Taking first the solubility of the alkalies in water charged with carbonic oxide CO_2 at 25 degrees C. and comparing the results with the weight of calcium oxide found in the drainage water from the sand pots it is seen that the calcium sulphate, the one having the greatest depletion, is the salt that is most soluble in carbonic acid. Magnesium carbonate second, calcium carbonate third, calcium oxide fourth, and calcium phosphate fifth. Barium hydrate does not seem to be affected either one way or the other in respect to carbon dioxide, its inactivity being in the most part due to its very alkaline properties.

A study of the results of the effect of carbonic acid on calcium oxide in the three soils show that a decided decrease in depletion occurred, which is in accordance with the solubility of calcium oxide in a carbon dioxide solution, checking its rate of movement by forming the insoluble carbonates, thus answering the question in regard to the small difference found between the very soluble and the insoluble carbonates and phosphates of lime, and confirming the statement that calcium oxide when applied to a soil is readily converted into a carbonate by the carbonic acid held by the soil.

In the decomposition of organic matter, vegetable matter or manure in the soil, the most important change which takes place is the gradual conversion into gases of a larger portion of the organic elements. Of these gaseous products the most abundant is carbonic acid gas (CO_2). It is in this form that the carbonaceous matter, which constitutes the chief portion of the manure, has to do with the mineral portion of the soil. The result of the formation of so much carbonic and other organic acids is to increase the amount of soluble mineral matter very considerably.

Another source of very great importance by which the soil receives carbonic acid is through the rain water. Rain water carries with it CO_2 taken from the air, which is given up to the soil as the water percolates through, and then reacts with the saline material having its effect with the different salts.

A good example of this effect is shown in the experiment with the pots under natural and artificial conditions. As was pointed out, more calcium oxide was obtained in the drainage from the pots under artificial conditions, that were treated with calcium oxide, than the pots under natural conditions. Whereas the pots under natural conditions, treated with calcium carbonate and calcium phosphate gave more calcium oxide up to the drainage water than the pots under artificial conditions, where distilled water was used instead of rain water.

The explanation of this is shown in the effect of CO_2 on calcium oxide in the three types of soils. Carbon dioxide forming an insoluble carbonate with calcium oxide, and its acid properties making the CaO, held by calcium carbonate and calcium phosphate more available.

Factors Influencing Diffusion of Lime.

Soluble salts in a soil are subject to a great many irregular changes. They may be concentrated in a solid form, or as a strong solution, at the surface; which would be found after active nitrification, after drought, and after the application of a dressing of saline manure. Opposite to this tendency to accumulate at the surface there is the action of rain, which washes the surface soil with water, the water in turn tends to carry all soluble salts into the subsoil, where the action of diffusion in a moist soil tends to equalize the proportion of salts throughout the whole mass.

The effects which will follow the descent of rainfall upon the surface of a soil are not so evident. In consideration of this, the most common action of water on soil, it must be distinguished between two cases, that is, whether the soil is dry or wet when rainfall takes place.

If a steady and continued rainfall takes place on the surface of a dry soil, free from fissures, the water descends through the soil as a liquid column, dissolving the salts it meets with, while the column is pushed further and further into the soil by the continual addition of rainfall at the surface. After a short time the upper layer of the soil, through which the column of water has passed, will be found entirely free from soluble salts, while at the lower surface of the descending column there will be found a narrow layer of concentrated salt solutions containing all the salts which have been removed from the surface soil.

For this action as described above to take place in its most striking manner it is necessary that the rainfall should be considerable and continuous; for diffusion is always at work, tending to re-establish the equal distribution of salts in the wet soil. With a heavy rainfall occurring in a short time the layer of salt solution carried downwards will be very narrow and highly concentrated. If, on the other hand, the rainfall is light and long continued, the layer of salt solution will be wider and the solution weaker. In any case as soon as percolation ceases, the salts carried down will begin to distribute themselves again in all directions through the wet soil.

If, however, the soil is moist when rain commences, although we have, as before, the same descending column of rain water, we have no longer a layer of highly concentrated salt solutions pushed before it; the rain water now simply displacing the solution already existing in the soil, and pushes this before it in a practically undiluted condition.

In a field soil where there are always numerous channels and fissures, formed by roots which have decayed, or by the passage of worms and by contraction during drought; the action of rain in washing out soluble salts near the surface is by no means so extreme as might be supposed from laboratory experiments made with powdered soils. Through the openings as described above a considerable portion of rain will reach the subsoil without having done any considerable damage in removing the soluble matter. Wherefore we would expect to find at a modern distance below the surface, first, the discharge from the mass of soil which contains the greater portion of the soluble salts; second, the water which comes directly from the surface through the channels as described above containing little or no soluble matter.

The slower the passage of water through the soil, the larger is the quantity of water required to remove the soluble salts. The effect produced by diffusion becomes very considerable whenever time is allowed for their manifestation, and these effects are in the main conservative, and tend to counteract the removal of lime from the soil by rain water. Very heavy or continuous rains are very injurious to the surface of shallow soil, the soluble salts being washed out below, whereas the matter carried down by rain in a deep soil, has the greater opportunity of rising again by diffusion when rain has ceased.

The salts most generally produced in the soil by this process of solution are calcium carbonate, resulting from the solvent action of water containing carbonic acid on the calcareous constituents of the soil, and calcium nitrate, reproduced during the process of nitrification. The solution of calcium carbonate may occur throughout a considerable depth of soil, though most vigorously in its upper layer. The production of nitrate is practically confined to the surface soil.

Besides the calcium and magnesium salts derived from the calcareous matter in the soil, soluble salts of potassium and sodium may also arise if the soil contains imperfectly weathered silicates.

Large quantities of nitrate of sodium, sulphate of ammonium, potassium salts, chloride of sodium and soluble phosphate, sometimes are applied to the soil in the form of manure. Some of the substances thus applied are chemically retained by the soil, but their acid radicals as the nitrates, chlorides, carbonates and sulphates are not retained and appear in solution in form of calcium and magnesium salts, which are in turn carried out by the drainage water.

*The loss of lime salts from the soil by the drainage water is greatly influenced by the amount of ammonium salts contained by the land, the salts consisting chiefly of sulphate, chloride, and nitrate of calcium. Probably the whole of the sulphuric acid and chlorine contained in the ammonium salts unites with lime and magnesium in the soil; the resulting salts being soluble they will be removed, to a greater or less extent, in the drainage water as soon as a sufficient rainfall occurs. Loss of lime will also occur as nitrate of calcium. Ammonia is speedily oxidized to nitric acid in the soil; this acid combines with lime and magnesium in the soil, and nitrates, calcium and magnesium appear in the drainage water. Supposing ammonium salts were applied to the soil as manure and the whole of the ammonia were converted into nitric acid and that resulting nitrites were entirely lost by drainage, then the soil would suffer a much further loss of lime and magnesium. In a cropped soil however, the loss on this score would be greatly diminished, as the crops would assimilate a large part of the nitrites formed. Thus the action of ammonium salts, when added to the soil poor in lime, should always be borne in mind.

†Nitrate of sodium when applied to the soil would have little or no effect of removing the lime, as there are no known chemical reactions within the soil by which nitrate of sodium could render lime or magnesium soluble. Sulphate of sodium and potassium on the other hand would tend to increase the diffusibility of lime, the sodium and potassium being retained by the soil, while the sulphuric acid passes into the drainage as sulphate of calcium.

---

*Warington—P. P. of Soils.

†Ruthamsted Lab. (J. Rog. Agri. Soc. 1881).

REVIEW.

Different substances have very different rates of diffusion, as is found by the work of Graham and Marignac, but for the present purpose there will only be noticed those substances which may occur in solution in the soil.

Marignac (Amer. Chem. Phys. (5), 2,579) working on the comparative diffusibility of the acid and bases, found that the most diffusible salt of any metal is the chloride; the nitrate is but little less diffusible; the sulphate is considerably less diffusible than either the chloride or nitrate; the carbonate is rather less diffusible than the sulphate. The diffusibility of phosphates does not seem to have been determined, but is of little agricultural importance, as phosphoric acid occurs only in very minute quantity in soil solution, and when applied in a soluble form as manure, it is quickly precipitated upon the surface of the soil particles.

Of the ordinary bases, the most diffusible is potassium; then following in decreasing order, ammonium, sodium, calcium and magnesium. As potassium and ammonium are somewhat readily removed from solution by a fertile soil, their distribution by diffusion cannot generally be long continued.

The difference in diffusibility of different salts will of course occasion their separation in the soil, the most diffusible salt always traveling fastest. Graham diffusing mixture·containing equal weights of chloride and sulphate of sodium; in the most distant part of the solution the proportions found were chloride 90.6, sulphate 9.4. Fertilizers when applied to a moist soil must be quickly separated into its constituents salts, the potassium, sodium and magnesium compounds having each very different rates of diffusion. A similar separation of the constituents will occur when any salin mixture is applied to the soil.

Urea, according to Graham, is a substance of very considerable diffusive power, nearly equal in this respect to sodium chloride. As urea is also not retained by soil, it is clear that the application of fresh urine to soil will result in a distribution of nitrogenous matter within it, similar for a time—until the conversion of urea into ammonium carbonate has taken place.

Thus, according to Warrington, some of these facts mentioned are of considerable agricultural importance. The salts having the greatest value as plant food, the nitrates, and the salts of potassium and ammonium are also those which will diffuse most rapidly in the soil. The differences in the diffusibility of the bases are also of practical importance, nitrate of sodium will clearly diffuse in the soil much more rapidly than nitrate of calcium. This fact indicates an additional difference between the behavior of nitrate of sodium and ammonium salts when applied as manure to a soil, the nitrification of the latter in the soil resulting, as is well known, in the production of nitrate of calcium

SUMMARY.

In summing up the results obtained on the investigation of the rate of diffusion and depletion of different limes in different types of soils the following facts are observed:

Different substances have very different rates of diffusion, and in consideration of the salts used in this investigation the most diffusible salt of any is calcium sulphate; magnesium carbonate is considerably less diffusible than calcium sulphate; calcium carbonate is less diffusible than magnesium carbonate; calcium oxide is but little less diffusible than calcium carbonate; calcium phosphate less than either the carbonate or oxide, and barium hydrate considerably less than either of the six salts studied.

The rapidity of diffusion depends on the difference in the concentration of the salts; the greater the difference the more marked the effect will be.

Diffusion is considerably influenced by temperature, and becomes more rapid in respect to some salts as the temperature rises.

Of the three soils used, salts diffuse most rapidly through the sand soil; less rapidly through the loam soil and only to a slight extent through the clay soil.

The movements of salts in a soil are to a large extent governed by the physical constitution of the soil; the soil having the coarser particles allowing the salts to diffuse more rapidly than the soil with many small particles.

The amount of lime removed from the soil by the drainage water is the greatest source of loss of lime to the soil, and the extent of this loss depends entirely on the kind of lime added to the soil, and the kind of soil limed.

The carbonic acid in a soil plays no insignificant part on the influence of diffusion of lime in the soil, checking the movement of calcium oxide by forming insoluble carbonates, and forming more soluble salts with the insoluble forms as calcium phosphate, carbonate, sulphate, and magnesium carbonate.

The amount of lime removed from the soil, by the crop is in the most part very small, yet it is one of the principal means by which lime is taken from the land. In considering the exhaustion of the soil by the crop it is readily seen that exhaustion by this means is in no way so great as is suffered by depletion.

THE PRACTICAL APPLICATION OF THE RESULTS.

Clay soils held or fixed all kinds of lime better than sandy soils.

The loss of different kinds of lime from a clay soil was much less but relatively the same as with the sandy soil.

The results with the loam soil stood approximately between the clay and sand soil—showing that the greater the amount of sand in a soil the less is its capacity for holding or fixing lime or in other words the more sand in a soil the more frequent should it be limed.

Magnesium lime suffered a greater loss through drainage than calcium lime.

Carbonate of lime was more easily removed by drainage water than caustic or burnt lime.

Gypsum or "land plaster" was more easily lost from the soil by drainage than any other form of lime.

These results would seem to indicate that the presence of sulphates in the soil, which could unite with the lime of the soil, would have a tendency to cause a loss of lime through leaching.

Soil water charged with carbonic acid gas increased the solubility of the carbonate, phosphate, and sulphate of lime but decreased the solubility of the caustic or oxide of lime. These facts would seem to indicate that on soils which contained much decomposing organic matter that caustic lime would be fixed and held relatively better than on soils which were deficient in organic matter. The results of applications of carbonate of lime would be the reverse of that obtained with caustic lime. These results would seem to indicate that caustic lime would be the most active in correcting acidity.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 167. MAY, 1912.

CHANGES IN POTATOES DURING STORAGE.

By Charles O. Appleman.

Introduction and Outline.

This bulletin is an outgrowth of investigations now in progress on the nature and control of the processes of "after ripening" during the dormant period of the potato tuber. Althouh the tables and data were compiled from the writer's own work, he does not claim originality for all of the general facts here presented.

These changes are treated under the following heads:

1. Relation of temperature to starch and sugar transformations.
2. Changes due to respiration and its dependence upon external and internal factors.
3. Causes of loss in weight.
4. Effects of sprouting.

General.

The potato tuber is a living thing in which chemical and physical processes are continually going on. These processes are influenced by external conditions and often involve transformations which greatly effect their culinary and seed value. A knowledge of these changes and their relations to external conditions is important in order that the quality of the potatoes may be least impaired during handling and storage.

Relation of Temperature to Starch and Sugar Transformations

The potato tuber is principally a carbohydrate food. Not only the food value but the desirable qualities of cooked potatoes are dependent largely upon the relative amounts of starch and sugars present. Mealiness is only possible where the percentage of starch content is high and sugar low. In boiling water the starch swells within the cells, producing pressure on the cell walls. If this pressure is sufficiently great it causes the cells to enlarge and assume a spherical form. This causes them to separate easily, which gives the mealy condition of mashed potatoes. Under certain conditions secondary factors such as abundant coagulated protein and pectins may play a role in causing the cells to adhere, giving a pasty mass. The accumulated sugar in the potato not only means less starch and sweet taste, but also the undesirable flavor that goes with high sugar content. The destruction of these substances during storage, of course, results in actual loss of food value.

It is then obvious that among the most important changes occurring during storage are those which involve the starch and sugars. There are three processes continually going on in the potato tuber which are concerned with the transformation and disappearance of these substances; respiration, which consumes sugar by converting it into carbon dioxide and water; conversion of starch into sugar by a ferment called diastase, and the process which changes sugar back into starch. These processes are greatly and differently influenced by external factors, the most important being temperature. The following tables show some important temperature relations to starch and sugar transformations during storage. Nine tubers with a total weight of approximately three pounds were used for each set of analyses. A composite sample was thus obtained. The figures indicate simply the percentage of starch and sugar in the pulp at the time of analysis. They do not show the total actual loss of these substances under the storage conditions. To do this it would have been necessary to calculate the percentages of each set of analyses on the original weight of the tubers. Under the cold, moist conditions where evaporation and respiration were slight, the difference in the two sets of figures would be very little. On the other hand, if the loss by evaporation and respiration were relatively great during storage, the percentages might even show an apparent slight increase in total carbohydrates.

TABLE I.

Shows Sugar and Starch Content of Summer Harvested, Green Mountain Potatoes Stored in Vault with Only Slight Variation in Temperature.

Temperature was never below 50 degrees F.

Date of Analysis	Moisture Per Cent	Total Sugar		Starch	
		Fresh Weight Per cent	Calculated to dry basis Per cent	Fresh Weight Per cent	Calculated to Dry Basis Per cent
September 4	82.06	.307	1.71	13.38	74 56
September 21	81.56	.303	1.64	13.43	72.85
October 12	81.10	.278	1.47	14.16	74.90
November 8	80.77	.229	1 24	14.07	73.15

TABLE II.

Shows Relation of Sugar and Starch Content to Changing Low Temperatures. Autumn Harvested Green Mountain Potatoes Stored in Vault.

Date of Analysis	Range of Storage Temperature	Moisture Per cent	Total Sugar		Starch	
			Fresh Weight Per cent	Calculated to dry basis	Fresh Weight Per cent	Calculated to dry basis per cent
November 28	42° F.-38° F.	80.44	1.10	5.41	14.09.	74.50
December 20	38° F.-35° F.	80 26	1.77	8.97	14.01	70.96
January 13	35° F.-29° F.	79.45	2.14	10.39	14.38	69.80
February 13	32° F.-29° F.	80.06	4.15	21.35	12.68	66.10

TABLE IV.

Shows Change in Percentage of Sugar and Starch Occurring in Potatoes Stored at Constant Temperatures.

Days in Storage	Total Sugar Per cent of Fresh Weight		Starch Per cent of Fresh Weight	
	68° F.-70° F.	30° F.-32° F.	68° F.-70° F.	30° F.-32° F.
7	54	.68	.....	.....
15	54	1.55	14.35	12.88
34	.55	2 87	14 20	11.53
55	.62	3.29	13.85	11.10

It will be noticed that the sugar accumulates at the expense of the starch. The sugar increases rapidly when the temperature reaches 32° F. Potatoes begin to freeze when the temperatuure is between 28° F. and 26° F. It is not, however, the process of freezing, which causes the potatoes to become sweet. Frozen potatoes do not accumulate sugar. It is the long exposure just above freezing which causes the sugar to accumulate. If frozen potatoes are sweet it is because they had become sweet before they were frozen.

Like many other chemical processes, the enzyme action which converts the starch into sugar is slowed down by the accumulation of its own products. At a constant temperature of 32° F. the sugar accumulation is slowest the first week. A short exposure of a few days will show only a slight change in sugar content. After this it becomes gradually more energetic up to four or six weeks and then slows down again. During long exposure the total sugar frequently reaches as high as three to four per cent. of fresh substance. Individual tubers show considerable variation in their ability to become sweet at low temperature.

Although long exposure just above freezing is necessary to cause any considerable degree of sugar accumulation, yet most tubers will show a slight increase at 38° F. and some even at 43° F. Probably all potatoes fail to show any accumulation of sugar at 45° F.

An explanation of the phenomenon of becoming sweet involves all three of the above processes, and their different relation to temperature. From 46°-50° F. the processes of respiration and synthesis of starch from sugar consume all the sugar that is formed by the action of the diastase, therefore, no sugar accumulates. Below this temperature the two former processes are inhibited to a much greater extent than the latter. Consequently, sugar begins to accumulate. At 32° F. respiration and starch synthesis are so slight that a large percentage of the sugar formed accumulates; the supply is greater than the consumption.

Tables I and II incidentally show that fall harvested potatoes are much richer in total carbohydrates than summer harvested potatoes of the same variety. By taking an average of all the analyses of each table, the summer harvested potatoes show only 14.07 per cent. (75.38 per cent. dry basis), while the autumn harvested tubers show 16.08 per cent. (81.87 per cent. dry basis).

If potatoes which have become sweet are brought into a room with a temperature of 70°-75° F. for a week, about four-fifths of the sugar will be converted back into starch. The remaining fifth will be lost through respiration. This fact is important, as it furnishes a means of restoring potatoes to their normal sugar content after they have become undesirable on account of accumulated sugar. The very slight change in texture caused by this short exposure at room temperature just before using is due to a very slight loss of water by evaporation and to a diminished turgor within the cells resulting from the sudden removal of sugar by starch synthesis and respiration. The culinary value of the potatoes is thereby not in the least impaired. A longer exposure of three or four weeks in the cellar or vault after the temperature has risen to 45° or 50° F. will remove most of the accumulated sugar.

TABLE V.

Shows Disappearance of Accumulated Sugar from Potatoes by Short Storage at Room Temperature.

Green Mountain Potatoes	Moisture Per cent	Sugar		Starch	
		Fresh Weight Per cent	Calculated to dry basis Per cent	Fresh Weight Per cent	Calculated to dry basis Per cent
When taken from vault	79.45	2.14	10.41	14.38	69.95
After 8 days Storage at 68° F. to 70° F. . .	78.80	.46	2.17	16.58	78.21

RESPIRATION.

The sugar consumed by respiration is absolute loss, and, under certain conditions this loss may reach consisderable amounts. As the starch is the original source of the sugar, there is a corresponding loss of the same. The rate of respiration in the tuber at any given time depends upon a variety of conditions. The most important of these is temperature. As the temperature rises within certain limits, respiration increases. Ziegenbein found the optimum for potatoes to be about 112° F. Above this point it decreases again. Below this it gradually decreases as the T. falls and becomes very weak around the freezing point.

Accumulated sugar, germinating buds, moisture and light, are secondary conditions which influence the rate of respiration. Tubers in which sugar has accumulated will respire several times faster than non-sweet ones. This increased rate, however, obtains only as long as the accumulated sugar lasts. A sudden increase in respiration and consequent loss in starch occur when the buds begin to germinate. High water content of the tubers and moist surrounding atmosphere favor respiration. Light also exercises a favorable influence on it. The process of respiration produces heat. The heating of potatoes in large heaps or bins is due to rather high respiration and poor ventilation, making it impossible for the produced heat to escape. As this heat accumulates and warms the atmosphere surrounding the tuber it accelerates the very process which produces it. Old potatoes under the same conditions, will respire faster than new ones.

LOSS IN WEIGHT.

The outer skin of the potato is very efficient in preventing loss of water by evaporation. An unpealed tuber lost only two-tenths of a per cent. of its weight in 72 hours, while a pealed one lost 40 per cent under similar conditions. In spite of this fact there is a considerable loss of weight during long periods of storage. The loss is due to evaporated water and respired carbon dioxide. In general, conditions most favorable for evaporation and respiration will cause the most loss in weight. A warm atmosphere is favorable for both processes. A warm, dry air is most favorable for evaporation. Potatoes suffer the least loss in total weight in a cool, dark, damp situation. Excessive moisture, however, is to be avoided, as it not only favors fungus diseases, but also permits a much more vigorous growth of sprouts after they once start. A moderately dry atmosphere, comparable to a well-ventilated cellar, is best in the long run. There is also a judicial limit to the degree of low temperature on account of sugar accumulation and its accompanying evils. Considering the opposite relation of respiration and sugar accumulation to temperature, a good compromise temperature would be between 38° and 42° F. For seed potatoes a temperature slightly above freezing is preferable, as sugar accumulation is not objectionable, and may even be beneficial.

Under similar conditions the loss of total weight is by far the greatest directly after digging. This is due to the fact that the tender skin is much more permeable to water than the completely suberized skin of old potatoes. In a moderately dark, deep, dry cellar, with a temperature of 42°-52° F., Wollny found the average loss of 12 varieties to be 2.02 per cent. of the original weight for the month of October. During March the loss amounted to only .41 per cent. It then began to increase again on account of warm weather. The total loss of original weight from October 1st to May 1st was 6.17 per cent., while from May 1st to October 1st it was 21.5 per cent. The relative loss of water and carbon dioxide depends upon changing conditions. On the average, the water loss is greater than the gas. The loss in weight during the spring and summer months would, of course, be accelerated on account of the sprouting under the above storage conditions.

TABLE VI.

Shows Depletion of Starch and Protein in Sprouting Potatoes. Percentages Were Calculated on Original Weight, in Order to Show Actual Loss.

Date of Analysis	Tubers	Starch	Protein
February 3 .	Before Sprouting	16.05	1 90
March 26	After producing sprouts equal to 3.3% of total weight used for Analysis.	13.20	1.40

EFFECTS OF SPROUTING.

The composition of potatoes is considerably altered when sprouting begins. Sugar, starch and proteins are rapidly depleted. Loss of water by evaporation is greater, owing to the exposed surfaces of the sprouts, whose walls are readily permeable to water.

Sprouting will not occur under the most favorable conditions during the natural rest period. McCormick potatoes were dug November 11th and planted at once in moist saw dust in the green house. On January 1st only a few buds were beginning to germinate. Nearly all tubers showed germinating buds on Febrauary second. Green Mountain potatoes, harvested August 16th and placed under growing conditions, did not sprout until October 19th. Early and Southern grown potatoes have a shorter rest period. Some varieties of Southern grown potatoes have a rest period of only four to six weeks. At the end of the rest period the buds will begin to germinate even under very adverse conditions for growth. The minimum sprouting will occur under cold *dry* conditions. Removing the sprouts repeatedly does not seem to weaken the buds for seed; the eighth crop of sprouts from the same buds was just as vigorous as the first.

SUMMARY.

Sugar accumulates in potatoes at the expense of the starch when the temperature falls to 38° F. The rate of accumulation is most rapid between 32° and 29° F.

Potatoes exposed to the above temperatures for only a few days will show a very slight sugar accumulation. A long exposure is necessary before the accumulation becomes significant. The maximum of three to four per cent. is reached in four to six weeks.

Freezing does not begin until the temperature is between 28° and 26° F.

If potatoes, which have become sweet through long exposure to low temperature, are brought into a room of 70°-75° F. for a week, about four-fifths of the accumulated sugar will be converted back into starch; the remaining fifth will be lost through respiration. A longer exposure of three or four weeks in the cellar or vault after the temperature has risen to 45° or 50° F. will remove most of the accumulated sugar.

Respiration converts starch and sugar into water and carbon dioxide. This process is continually going on in stored potatoes.

The rate of respiration is influenced most by temperature. It increases as the temperature rises within certain limits and gradually decreases as the temperature falls, becoming very weak just above the freezing point.

The rate of respiration is also accelerated, by accumulated sugar, germinating buds, moisture and light.

Respiration produces heat. The heating of potatoes in large heaps or bins is due to high respiration and poor ventilation.

Potatoes lose in weight during storage, due to evaporated water and respired carbon dioxide. Warm, dry conditions favor evaporation. Loss by carbon dioxide is greatest at high temperatures.

Under similar conditions loss in weight is much greater right after digging than during the winter months. The rate of loss increases again with sprouting and warm weather.

Starch, sugar and proteins are rapidly depleted in sprouting potatoes.

The minimum sprouting at the end of the rest period will occur under cold, dry condition.

Removing the sprouts repeatedly does not seem to weaken the buds for seed.

CONCLUSION.

From the above facts it is evident that a combination of processes must be taken into consideration in deciding upon the best storage conditions for potatoes. The best conditions in respect to a single process might be the most unfavorable when considered from the standpoint of all processes combined. A storage temperature slightly above freezing is best for seed·potatoes, but for culinary purposes a moderately dry, well ventilated cellar or vault, with a temperature ranging between 38° and 42° F. is preferable.

INDEX.

Page.

A.

Acknowledgment. "Peach Culture" 149
Administration and Division of Work v
Age, and Its Relation to Egg Production 82
Agricultural Types of Weeds 5
Apple, Fungus of 263
Apple in Foliage, Treatment for 269
Apple, Insect Pests of 263

B.

Biological Laboratory, State xvii
Bordeau Mixture, Preparation of 271
Botanical and Pathological Investigations xiv
"Boys' Corn-Growing Contest" 273
    Method to be Followed 276
    Results of 274

C.

Carnations 99
"Changes in Irish Potatoes During Storage" 327
Chrysanthemums 99
Comparison of Quality of Seed, Graphic 239
Concentrated Lime-Sulfur, Preparation of 271
Concentrated Solutions, Table for. Scale Insects 226
Contents iv
Corn-Growing Contests, Boys' 273
Corn-Growing Contests, Outline for Conducting 281
Corn-Growing Contests, Record of 284
Corn-Growing Soil, Seed Bed, Planitng, Cultivation, Etc 278
Corn, Suggestions for Growing 278
Cost of Production of a Peach Orchard 184
Cover Crops, Peach Orchard 137
Creosote, Volatilization of 258
Cultivation of Corn 280
Cultivation. Strawberries 196

D.

Dairy Investigations, Demonstrations and Extensions xv
Damage Done by Weeds 2
Demonstration Work xvi
Demonstrations vii

Page.
Demonstrations, Public Spraying 231
Diffusion and Depletion of Lime in Soils 285
Diseases. Strawberry 219
Diseases. Peach 187
Drafts, Relation of, to Mildew 73

E.

"Egg Production, Increasing the" 81
Eggs, Effect of Feeding Corn on Color of Yolk 94
Eggs, Persistence of Fertility After Removing Male 93
Eggs, Time Required to Become Fertile After Adding Male 91
Elimination of the Old Fowls 88
Entomological Investigations xiv
Exposure and Air Drainage. Peach 115

F.

"Factors Influencing Diffusion and Depletion of Lime in Soils". 285
Fence Posts, Methods Employed in Preservation of 244
    Does it Pay to Treat? 257
    New Experiments 249
    Results of Treatment 260
    Seasoning 250
    Two-tank Method of Treatment 252
Fertilizers for Corn Growing 281
Fertilizers, Strawberries 195
Financial Conditions and Appropriations vii
Fowls, Age of, In Relation to Egg Production 82
Fowls, Elimination of the Old 88
Fowls, Individual Variation 87

G.

Grading and Packing. Peach 141
Grain and Forage Crop Investigations xiii
Graphic Comparison of Quality of Seed 239
Greenhouse Experiments 97
Greenhouses, North and South vs. East and West 107

H.

Habits of Weeds 3
Harvesting. Peach 141
Historical Sketch. Peach 111
Horticultural Investigations xiii
"How Is Lime Distributed Through and Lost from Soil?" 285

Page.

I.

"Increasing the Egg Production"........................... 81
    Summary 90
"Increasing the Durability of Fence Posts".................... 243
Index to Bulletin No. 155, "Maryland Weeds"................ 65
Insects. Peach 188
Insects. Strawberry 219
Investigations ....vi, xii
Irish Potatoes, Changes in During Storage.................. 327

L.

Laboratory, State Biological............................... xvii
Lime Diffusion 321
Lime Experiment, Discussion of Object of, Methods Involved
    and Results with Summary of.........................285-325
Lime, Loss of from Soil.................................... 312
Lime, Practical Applications of............................ 325
Lime Removed from Soil by Crops........................... 314
Lime-Sulfur, Experiments and Results with Use of........... 266
Lime-Sulfur, Preparation of Self-Boiled.................... 220
Low Heading. Peach Culture............................... 120

M.

Manure and Fertilizers. Peach..............................139
Maryland Conditions. Peach................................ 114
"Maryland Weeds and Other Harmful Plants"................ 1
Mildew, Cause of. Roses................................... 73
Mildew, Controlling by Burning Sulfur...................... 78
Mildew, Controlling by Vaporizing Sulfur................... 79
Mildew, Experiments 76
Mildew, Relation of Drafts to.............................. 76
"Miscellaneous Greenhouse Experiments"..................... 97
    Conclusion 100
Mulching, Strawberry 197
Mutilated Peach Trees..................................... 135

N.

Nature of Weeds.. 2
Needs of Station.. xvi
North and South vs. East and West Greenhouses.............. 107

Page.

O.

Old Soil vs. New Soil.......... 104
Orchard Heating. Peach.......... 140
Orchards, Old Peach.......... 139
Orchards, Young Peach.......... 136

P.

"Peach Culture" 111
  Acknowledgment 149
  Advantages of Low Heading.......... 120
  Age and Sizes of Trees.......... 118
  Cover Crops 137
  Cost 184
  Diseases 187
  Exposure and Air Drainage.......... 115
  Grading 142
  Harvesting 141
  Historical Sketch 111
  Heeling 118
  Insects 188
  Mutilated Trees 135
  Manure and Fertilizers.......... 139
  Natural Conditions 114
  Ordering Trees 117
  Old Orchards 139
  Orchard Heating 140
  Planting 119
  Preparation of Land.......... 117
  Pruning 121, 131, 136
  Packing 141
  Propagation 147
  Soils 114
  Thinning 140
  Types 148
  Varieties 149
  Water Drainage 117
Peach, fungus of.......... 263
Peach in Foliage, Treatment for.......... 269
Peach, Insect Pests of.......... 263
Picking and Packing. Strawberry.......... 197
Planting Corn 279
Plants, Harmful 1
Plant Physiological Investigations.......... xiv
Plants, Poisonous 61
Plants, Setting. Strawberry.......... 196
Potatoes During Storage, Changes in 327
Potatoes During Storage, Respiration of 331

Page.
Potatoes During Storage, Loss in Weight.................. 331
Potatoes During Storage, Sprouting of 333
Potatoes During Storage, Conclusions 334
Poultry. Also see "Eggs" and "Fowls."
Poultry Appliances, Trap Nests........................... 85
Poultry, Experiments with 81
Poultry Investigations xv
Preparation of Land...................................... 117
Propagation 147
Publications xii
Public Spraying Demonstrations........................... 231
Purity of Seed... 236

Q.

"Quality of Seed, The"................................... 235

R.

Recommendations xvii
Renewing Old Beds. Strawberry............................ 197
"Rose Mildew" 73
    Observations and Conclusions......................... 79
Roses 98
Roses, Ordinary vs. Spray System of Watering............. 108

S.

San Jose Scale Insects 271
San Jose Scale, Spraying Tests 222
Sawdust in Manure Used in Flowering Plants............... 97
Seed Bed. Corn 278
Seed, Clean 17
Seed Corn 281
Seed, Graphic Comparison of Quality of................... 239
Seed Investigations xvii
Seed Law 25
Seed, Standards of Purity of............................. 236
Seed, Table Showing Quality of........................... 238
Self-Boiled Lime-Sulfur, Preparation of.................. 270
Sex. Strawberry 196
Soil and Climatic Conditions. Strawberry................. 193
Soil and Fertility Investigations xvii
Soil and Fertilizer Experiments with Violets............. 101
Soil for Growing Corn.................................... 278
Soil, Old vs. New.. 104
Soil, Peach Culture...................................... 114
Solutions, Concentrated, Table for Diluting. Scale Insects..... 226

	Page.
Spraying Demonstrations, Public	231
Spraying, Prompt and Thorough	271
Spray, Necessity of Summer	268
State Biological Laboratory	xvii
"Strawberries"	193
Cultivation	196
Diseases	219
Fertilizers	195
Insects	219
Mulching	197
Picking and Packing	197
Plants, Setting	196
Renewing Old Beds	197
Soil and Climatic Conditions	193
Soil Preparation	194
Sex	196
Varieties	194, 199, 206, 207
Sulfur, Burning for Controlling Mildew. Roses	78
Sulfur, Vaporizing for Controlling Mildew	79
Summer Spray, Necessity of	268
Sweet Peas	100

T.

Terrapin Scale Insects	221
Terrapin Scale, Spraying Tests for Control of	227
Thinning Fruit. Peach	140
Trapnest, Value of. Poultry Appliances	85
"Treatment for the San Jose Scale and Terrapin Scale Insects"	221
Trees, Peach	117
Types. Peach	148

V.

Varieties. Peaches.	149
Varieties. Strawberries	194, 199, 206, 207
Variation, Individual. Fowls	87
Violets, Soil and Fertilizer Experiments With	101
Volatilization of Creosote	258

W.

Water Drainage. Peach	117
Weed Eradication, Clean Cultivation for	7
Weed Eradication, Spraying for	10
Weed Control, Method	6
Weeds, Agricultural Types	5
Weeds, Damage Done by	2

Page.
Weeds, Fifteen Worst 41
Weeds, Habits 3
Weeds, Maryland, and Other Harmful Plants 1
Weeds, Maryland, Key to 26
Weeds, Nature of 2
Weeds of Maryland 25
Weeds, Other 45
Wood, Best Treatment for Each Species 254
Wood, Cost of Treatment .... -
Wood, Reasons for Decay of 248

MARYLAND & RARE BOOK ROOM
UNIVERSITY OF MARYLAND LIBRARY
COLLEGE PARK, MD.

DO NOT CIRCULATE

DO [redacted]IRCULATE